## Chapter 8. Effects of the HCP on the Species

# 8. Effects of the HCP on the Species

## 8.1 Introduction to the Analysis of Effects

This chapter describes how the habitat conservation measures in the City of Portland's (City's) Habitat Conservation Plan (HCP) will affect the covered species and the other species addressed in the HCP. The discussion is primarily organized by species. For each species (or group of species), the effects of the City's HCP conservation measures are discussed using a variety of metrics and more than one scientific analysis tool. The analysis of effects is first discussed for the four primary covered fish species for which there is considerable biological information and then for other species for which less data are available. The last part of this chapter provides a summary of effects of the City's covered activities on habitat, including detail on incidental land management activities.

### 8.1.1 Analysis of Effects on the Four Primary Covered Species

This HCP is primarily focused on four species of anadromous fish: fall Chinook salmon, spring Chinook salmon, winter steelhead, and coho salmon. Considerable biological and modeling data are available for these species. Each of these species is described in a separate section.

The analysis of effects on these fish species is presented from the following perspectives:

1. Effects of lower Bull Run River Conservation Measures
    - Habitat effects in the lower Bull Run River
    - Habitat effects in the lower Sandy River, below the Bull Run confluence, related to direct impacts in the Bull Run River
    - Habitat effects in the Columbia River related to the City's use of groundwater from the Columbia South Shore Well Field
2. Effects of Offsite Sandy River Basin Conservation Measures
3. Effects on Sandy River Basin Populations
    - Estimated effects expressed in terms of Viable Salmonid Population (VSP) parameters (McElhany et al. 2000)
    - Benchmark comparison of fish abundance in the Bull Run watershed

At the end of the effects discussion for each of these species, the City provides conclusions about the overall effects and the adequacy of the conservation measures for protecting the species.

### 8.1.2 Key Data Sources

To assess the effects on these four species, the City has used the Ecosystem Diagnosis and Treatment (EDT) habitat database and model developed by the professional biologists involved in the Sandy River Basin Partners. Habitat benefits of the City's HCP measures are expressed in terms of EDT environmental attributes. Definitions for these attributes are provided in Appendix D. Some of the environmental attributes are expressed as units per measure of habitat (e.g., large wood pieces per channel width). Other attributes are expressed as EDT ratings from zero to four, in which zero represents optimal conditions (zero negative impact) and four represents extremely poor or lethal conditions. The post-implementation conditions were derived according to the EDT methodology (see Appendix D) and in consultation with local fish biologists involved in the Sandy River Basin Partners.

The habitat benefit analysis takes into consideration the periodicity charts presented in Chapter 5 (Figures 5-4, 5-9, 5-13, 5-18, 5-22, 5-27, 5-31, 5-36, 5-40, and 5-41). These charts are specific to the Sandy River Basin and were developed by local biologists after consulting the available literature and comparable seasonal utilization depictions for these species.

### Reference Conditions

To help analyze and explain the effects of implementing the HCP, the City established reference conditions. The effects analyses contrast the expected change in habitat or population resulting from the City's conservation measures with the reference condition. The reference conditions differ according to the type of analysis and the location in the Sandy River Basin.

#### *Effects of Lower Bull Run River Conservation Measures*

The City chose not to use "current condition" as the reference condition for evaluating the effects of the Bull Run measures for two primary reasons. First, it was difficult to determine whether the current condition should be defined as when the fish were first listed as threatened species; just prior to release of the HCP for public review; or as another point in time. Second, the City has been gradually implementing some of the measures (e.g., flow and temperature management) so no one recent point in time would be representative of pre-HCP current conditions. Given these complications, the City instead compared the effects of the HCP measures to historical or "natural" conditions that would have existed prior to the existence of the water system (i.e., for analysis of base flows and water temperature).

In some cases, historical conditions did not apply or were not the only relevant metric. The City therefore also used criteria known to be protective of fish (e.g., the downramping rate of 2"/hour) or standard analyses used in fisheries science (e.g., weighted usable area). Weighted usable area (WUA) is an index of available instream habitat at various increments of flow. WUA estimates were generated for a number of flows in various reaches of the lower Bull Run River by R2 Resources Consultants (1998) using the Physical Habitat Simulation System (PHABSIM) model. The City used a "percentage-of-maximum" format for the WUA results. The incremental WUA values at various discharges that would be realized with the City's HCP flow measures were contrasted with the WUA values that would be obtained with natural streamflows (i.e., no Bull Run dams or diversions). The percentage of natural-flow WUA facilitates comparisons across species/life stages. For the effects analysis, the City also assumed that flows that provide WUA values that exceed 85-95 percent of the maximum natural-flow WUA are considered to be "optimal or near optimal flows" (R2 Resource Consultants 1998, NMFS 2002, IWSRCC 2003, R2 Resource Consultants 2004, Sutton and Morris 2004).

### *Effects of Offsite Sandy River Conservation Measures*

Current conditions were used as the reference condition for the offsite measures. The EDT database that compiled available habitat attribute data by river reach was the source of the current conditions data. The EDT model was used to estimate the fish habitat benefits that would derive from implementing the conservations measures. Estimated effects were then compared to the current conditions. Appendix E provides the percentage improvements. In addition, the effects analysis discusses the benefits that the conservation measures will have in addressing limiting factors for the four primary covered species in the affected reaches. Limiting factors were also derived using the EDT model.

### *Sandy Basin Population Effects*

The City analyzed the effect of implementing the HCP conservation measures on the populations in two ways:

- Estimated effects expressed in terms of VSP parameters
- Benchmark comparison of fish abundance in the Bull Run watershed

**VSP Parameters.** The National Marine Fisheries Service (NMFS) defines the health of an anadromous salmonid population in terms of the VSP parameters of abundance, productivity, life history diversity, and spatial structure (population distribution) (McElhany et al. 2000). Table 8-1 lists the VSP parameters and provides a short definition for each.

**Table 8-1. Definition of Viable Salmonid Population Attributes**

| Attribute | Definition |
|---|---|
| Abundance | The average number of fish of any life stage in a given stream, watershed, or basin; the more fish in the population the lower the extinction risk. Abundance is determined by the amount (capacity) and quality (productivity) of the habitat present in the basin. |
| Productivity | The maximum number of recruits (adults) produced by a single spawner. Productivity determines population resilience to mortality pressures, such as from fishing, dams, and further habitat degradation. Habitat quality (including water quality) is a major determinant of a population's productivity. This parameter is especially important when efforts are being made to reverse long-term downward trends in population abundance. |
| Diversity | The number of possible self-sustaining life histories exhibited by a population and the robustness of the genetic and environmental conditions that determine life history diversity. Populations that can sustain a wide variety of life-history patterns are likely to be more resilient to the influences of environmental change. |
| Spatial Structure | The number and location (distribution) and timing of salmon populations in the ESU or the basin. Wider distribution of fish abundance reduces fish susceptibility to catastrophic events such as flooding, chemical spills, or geologic disturbance. |

Source: McElhany et al. 2000.

The EDT model was run for two sets of scenarios: current habitat conditions with the reservoirs in place and the projected future habitat conditions after the City's HCP measures have been implemented. The projections for the VSP parameters were then compared and expressed as an increase (by percentage) in productivity, diversity, and abundance.

In general, there is less information available on how spatial structure relates to salmonid viability than there is for the other VSP parameters but historic spatial processes should be preserved (McElhany et al. 2000). For purposes of the spatial structure analysis, the City determined whether the four primary species would be enhanced in the known primary spawning reaches or whether the current distribution of the species would be increased from the HCP offsite measures.

**Benchmark Comparison of Fish Abundance in the Bull Run Watershed.** For each of the four primary species, an estimate of the increase in population abundance that would result from implementing the HCP was compared to an estimate of what the Bull Run habitat might be capable of producing if restored to the "modified historical condition." The modified historical condition is defined as the following:

- Pre-water-supply-system (1800s-era) flow conditions for the Bull Run, downstream from Dam 2 to the mouth of the Bull Run and upstream, including tributary streams draining into the reservoirs
- Including 8.3 miles of stream habitat assumed to be usable by steelhead above the waterfall at river mile (RM) 16.3 on the upper Bull Run River.
- Not including riverine habitat now inundated by the reservoirs
- Including fish passage and 100 percent fish passage efficiency (upstream and downstream) at the Bull Run dams ( a standard impossible to meet in practice)
- Including current-day out-of-basin impacts (e.g., ocean and estuary mortality)

The City believes the Modified Historical Bull Run Condition is a generous benchmark because it likely exceeds the highest possible current fish production potential of the Bull Run (assuming the reservoirs are left in place) and simulates a condition in which the City's water supply operations would have no ongoing impacts to salmonid habitat.

The City believes that the estimated production that would result from the HCP conservation measures is an underestimate of what is likely to result from full implementation of the HCP because it does <u>not</u> include the following measures:

- Implementation of the $9 million Habitat Fund (Measure H-30)
- Measures in the Little Sandy River (Measures F-4 and H-3)
- Carcass placement in Salmon and Zigzag rivers (Measures H-25 and H-29)
- Fish passage measures in Walker and Alder creeks (Measures P-1, P-2, and P-3)

### 8.1.3 Analysis of Effects on Chum and Eulachon

This HCP also covers chum salmon and eulachon. The current distribution of chum in the Sandy River Basin is nearly nonexistent and the eulachon run in the Sandy River has been absent in recent years (see Section 5.4.2 in Chapter 5 for more information on the distribution of the species). This HCP however discusses effects for these species should they become established in, or return to, the Basin.

### 8.1.4 Analysis of Effects on the Other Species Addressed in the HCP

The HCP addresses 18 species in addition to the six covered fish species. Five of the 18 species addressed are fish: rainbow trout, cutthroat trout, Pacific lamprey, river lamprey, and western brook lamprey. The other species addressed include amphibians (salamanders and frogs) and reptiles (turtles), birds, and one mammal.

The amount of biological information available for these other species varies, as do the applicable metrics and analysis tools. Each of these species is described in a separate section. The sections are grouped as follows: other fish species, amphibians and reptiles, and birds and mammal. A summary of effects is provided at the end of the species discussion. The level of detail for the effects analysis varies depending on the amount of available information.

## 8.2 The Four Primary Covered Fish Species: Fall Chinook, Spring Chinook, Winter Steelhead, Coho

### 8.2.1 Fall Chinook Habitat Effects

The HCP measures in the Bull Run watershed minimize the effects on juvenile and adult fall Chinook salmon in the lower Bull Run River to the maximum extent practicable. Offsite measures were selected to provide additional benefits for fall Chinook to help mitigate for the effects not avoided in the Bull Run. In addition, offsite measures that mitigate for impacts on other covered species also provide benefits for fall Chinook. Chapter 11 describes the City's commitment to fund the implementation of the necessary measures.

The potential effects of the City's Bull Run water supply operations and the HCP measures on fall Chinook salmon are described in this section. These effects are described in six subsections:

1. Effects in the lower Bull Run River—Describes the habitat effects of both the City's water supply operations and the HCP measures on lower Bull Run habitat for fall Chinook
2. Effects in the lower Sandy River—Describes the habitat effects of both the City's water supply operations and the HCP measures on habitat in the lower Sandy River for fall Chinook
3. Effects in the Columbia River— Describes the effects of using the City's groundwater supply at the Columbia South Shore Well Field on fish habitat in the Columbia River
4. Effects in Sandy River Basin watersheds—Describes the habitat effects of the offsite HCP measures on fall Chinook habitat in watersheds of the Sandy River Basin
5. Effects on the Sandy River populations by VSP parameter—Describes the population effects of all of the HCP measures (those in the Bull Run and those in the Sandy River Basin offsite locations) on abundance, productivity, diversity, and spatial structure for fall Chinook
6. Comparison to a population benchmark—Compares estimates of fall Chinook abundance under historical conditions to estimated abundance after HCP implementation

Summaries for all subsections appear in shaded boxes. A detailed description of the effects for the species in the geographic location follows each summary. Conclusions about the habitat effects on fall Chinook from implementation of all HCP measures, including a discussion of the predicted accumulation of habitat benefits over time, are provided on page 8-38.

**Summary of Effects on Fall Chinook in the Bull Run Watershed from Bull Run Water Supply Operations and HCP Measures**

The City identified 11 types of effects that the water supply operation could have on fall Chinook habitat in the Bull Run watershed. The City also analyzed the potential impacts on the base flow of the Columbia River from the HCP flow commitments.

- Impacts in the lower Bull Run that will be avoided or minimized include: flow downramping, water temperatures, Little Sandy base flows, riparian function and large wood, and spawning gravel.
- Impacts associated with blocked access to the upper watershed, low base flows, and reduced WUA values for fall Chinook cannot be fully avoided in the lower Bull Run River but will be mitigated by the Sandy offsite conservation measures.
- The City does not yet know whether redd scour flows and total dissolved gas (TDG) levels will impact fall Chinook salmon but these conditions will be studied and addressed, as necessary, through adaptive management provisions described in Chapter 9.
- The City's flow measures will have an extremely small effect on the Columbia River base flows, and fall Chinook habitat will not be affected.

Table 8-2 summarizes the effects of the water supply operations, the reference condition for each effect, and the predicted effects of the City's HCP conservation measures in the Bull Run watershed for fall Chinook.

Table 8-2. Effects of the Bull Run Measures on Lower Bull Run River Habitat for Fall Chinook[a]

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base Flows | Natural Bull Run base flows | |
| Winter/Spring Period (Juvenile Rearing) | | HCP flows will be approximately 80% of natural base flows during the juvenile rearing period. |
| Fall Period (Spawning) | | HCP flows will be approximately 60% of natural base flows during the spawning period. |
| Weighted Usable Area (WUA) | | |
| Juvenile Rearing | Natural flow | HCP WUAs for juvenile rearing will be close to 100% of the maximum WUA value. |
| Spawning | Weighted Usable Area | HCP WUAs for spawning will be 50 to 100% of the natural flow WUA levels. |
| Redd Scour Flows | Natural Bull Run base flows | City's flow regime will reduce the risk of redd scour compared to natural base flow conditions. The City will further study redd scour in the lower Bull Run River to verify this expectation. |
| Flow Downramping | Protective downramping rate: 2"/hour | The City will meet the protective downramping rate (2"/hour), and fish stranding effects will be minimal. |
| Little Sandy Base Flows | Natural flow; free-flowing | The City's commitment to forgo development of Little Sandy Water rights will avoid any effect on free-flowing conditions in the Little Sandy River. |
| Water Temperature | ODEQ standard: natural thermal potential | There will be minor, short-term water temperature impacts prior to installation of infrastructure improvements at Dam 1. Once the infrastructure improvements are in place, the City will meet the natural thermal potential of the lower Bull Run River and minimize water temperature effects on fall Chinook. |

Table 8-2. Effects of the Bull Run Measures on Lower Bull Run River Habitat for Fall Chinook[a], continued

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
| --- | --- | --- |
| Large wood | Natural wood routing and accumulation | Removal of large wood from the reservoirs to protect the water supply infrastructure does not substantially affect large wood in the lower Bull Run River because this channel is a transport reach. |
| Spawning Gravel | Natural levels of gravel recruitment | The City will replace the natural level of gravel recruitment in the lower Bull Run River. All impacts will be avoided. |
| Fish Access | Historical fish anadromy<br>Total blocked stream miles in Bull Run River watershed: 16.1<br>Blocked free-flowing miles in Bull Run River watershed (excluding the Little Sandy River): 1.3 (remaining miles are inundated by the reservoirs) | City will not provide access into the upper Bull Run River.<br>Approximately 10 miles of river will be provided in the Little Sandy River, of which 8 miles could be used by fall Chinook |
| Riparian Function | Mature riparian zones | City's riparian lands along the lower Bull Run River are currently in good condition. Protective measures in the HCP will maintain and somewhat improve these conditions as younger trees mature. |
| Total Dissolved Gases (TDG) | ODEQ standard: maximum of 110% saturation at flows below the 7Q10 flow.[b] | The City does not believe there are elevated TDG levels in the current range of anadromy at flows below the 7Q10 flow, but the City will continue monitoring to determine whether the ODEQ standard is being met. |

[a]For the list of conclusions about the habitat effects of all HCP measures on fall Chinook, see page 8-38.

[b]The 7Q10 flow is the ten-year, seven day average flood. The 7Q10 flow for the lower Bull Run River is 5,743 cfs.

### Habitat Effects in the Lower Bull Run River

The effects on fall Chinook in the lower Bull Run River are described in the following categories: streamflow (both base flows and WUA), water temperature, large wood, spawning gravel, access, riparian function, and total dissolved gases (TDG).

#### *Streamflow*

The City analyzed streamflow effects on fall Chinook by two means: comparing the effects of the HCP Bull Run base flows with the natural (pre-water-system) conditions, and determining the Chinook spawning and rearing weighted usable area (WUA) likely to result from the Bull Run flow measures. In addition, this section deals with critical fall flows, scour flows, downramping, and Little Sandy flows.

**Bull Run Base Flows.** The City compared an estimate of median monthly flows (50 percent exceedance flows) under natural conditions (i.e., no dams or diversions in the Bull Run watershed) with anticipated future flows during implementation of the HCP, assuming normal and critical years occur at the same frequency in the Bull Run as they have in the past. A 64-year hydrological record (1940–2004) was used for the analysis. The estimated median natural and HCP flows for the Bull Run River upstream of the Little Sandy River are shown in Figure 8-1 with peak periods of life-stage occurrence, as documented in the periodicity chart in Chapter 5 (Figure 5-9). All flow amounts are relative to the U.S. Geological Survey (USGS) Gauge No. 14140000 located at river mile (RM) 4.7 on the Bull Run River.

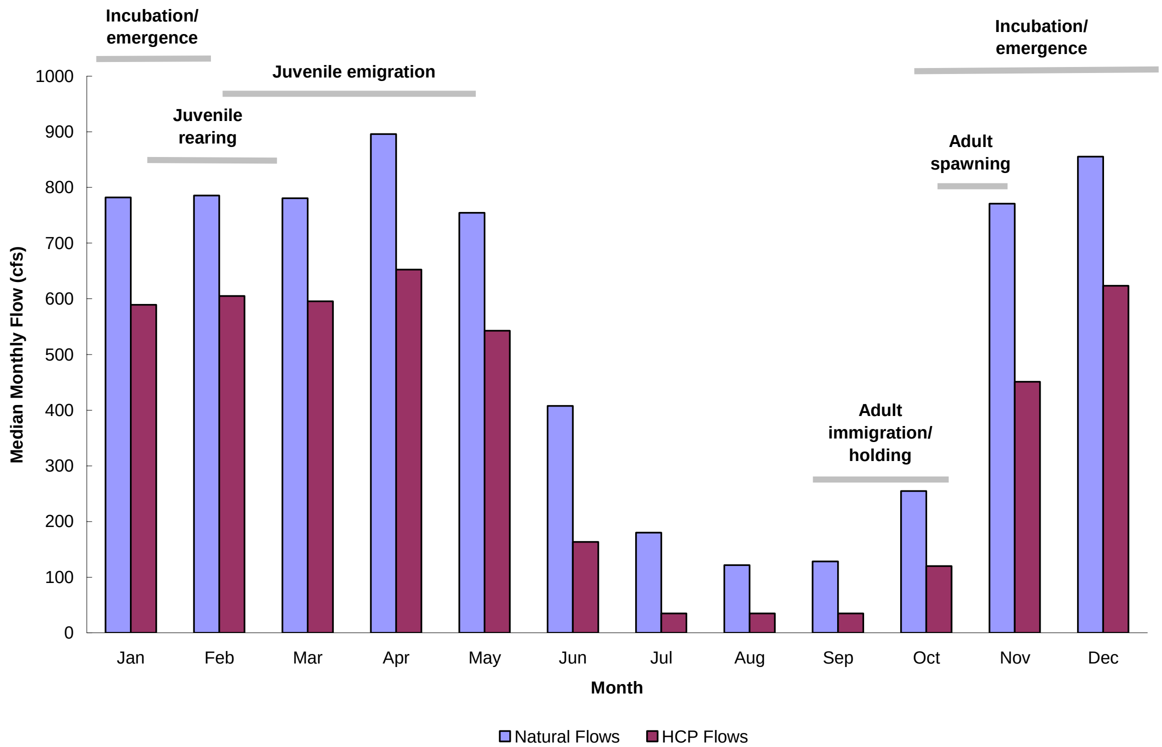


**Figure 8-1. Median Monthly Flows and Peak Periods of Occurrence for Fall Chinook Salmon in the Lower Bull Run River above the Little Sandy River Confluence[a]**

Source: Median monthly flows for the upper reach of the lower Bull Run River 1940–2004, taken at USGS Gauge No. 14140000 (RM 4.7).

[a]Although peak or important periods of occurrence are shown in this figure, some life-stage activities occur during non-peak periods as well. See Figure 5-18 for periods of occurrence for fall Chinook.

Table 8-3 lists the median natural flows and the median flows anticipated from implementing the HCP. The comparison is for flows in two segments: upstream of the confluence with the Little Sandy River (RM 3.0—RM 5.8), and downstream of the confluence with the Little Sandy River (RM 0—RM 3.0). For the portion of the Bull Run River downstream of the Little Sandy River, median flows were determined using the estimated Little Sandy median natural flows that would occur after the Little Sandy Dam is removed.[1]

[1] PGE has scheduled the decommissioning and removal of the Little Sandy Dam for 2008 which will restore natural flow conditions to the full length of the Little Sandy River. See Chapter 4, Section 4.1.5, Water Quantity and Water Rights.

**Table 8-3. Natural and HCP Median Flows by Month for the Lower Bull Run River**

| | Flows above Little Sandy (cfs)[a] | | Flows below Little Sandy (cfs)[b] | |
|---|---|---|---|---|
| **Month** | **Natural** | **HCP** | **Natural** | **HCP** |
| **January** | 782 | 611 | 938 | 765 |
| **February** | 785 | 608 | 957 | 776 |
| **March** | 780 | 606 | 932 | 760 |
| **April** | 896 | 672 | 1,072 | 846 |
| **May** | 755 | 563 | 898 | 709 |
| **June** | 408 | 196 | 487 | 274 |
| **July** | 180 | 35 | 213 | 67 |
| **August** | 122 | 35 | 141 | 54 |
| **September** | 128 | 35 | 152 | 55 |
| **October** | 255 | 120 | 304 | 166 |
| **November** | 771 | 427 | 924 | 608 |
| **December** | 857 | 654 | 1,031 | 829 |

[a]Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7).

[b]The sum of median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7) and median monthly flows taken at USGS Gauge No. 14141500, Little Sandy River (RM 1.95).

Upstream of the Little Sandy confluence, median HCP flows will be approximately 75 percent of the estimated median natural flows for the months of January through June. Downstream of the Little Sandy, the median HCP flows will be approximately 80 percent of the estimated median natural flows during this period.

**Effects of Base Flows on Fall Chinook Spawning.** Late-maturing Lower River Wild (LRW) stock of fall Chinook indigenous to the Sandy River Basin primarily spawn from about October 15 to December 31 (Lower Columbia River Fish Recovery Board [LCRFRB] 2004; Myers et al. 2003; ODFW 2001; ODFW 2005) and tule fall Chinook in the Sandy Basin primarily spawn from late September to mid-October (ODFW 2001). During the period, flows in the Bull Run River upstream of the Little Sandy will be approximately 65 percent of natural flow conditions. Flows below the Little Sandy River confluence will be about 60 percent of natural flows. Average median flows in the lower Bull Run River for this period will be approximately 400 to 500 cubic feet per second (cfs). R2 Resource Consultants (1998) concluded that these flows fall within the range of flows predicted to provide near-optimal spawning habitat conditions for fall Chinook salmon (see discussion below titled Bull Run Weighted Usable Area).

**Effects of Base Flows on Fall Chinook Rearing.** Flows are consistently highest during the winter and spring period, which will have a minimal effect on fall Chinook survival. The projected median flows under the HCP will be approximately 80 percent of the natural median flows. Averaged over five months, January through May, median flows will be about 610 and 770 cfs for the Bull Run River upstream and downstream, respectively, of the Little Sandy. These median flows provide ample water depths to protect egg incubation, fry emergence, rearing, and emigration for fall Chinook. Juvenile emigration (March–May) will occur before these flows decrease.

Flows during the early summer and the summer/early fall will have little or no effect on fall Chinook. Juvenile Chinook salmon have not been observed in the lower Bull Run River in the summer, and they are believed to emigrate from the watershed by late spring.

**Bull Run Weighted Usable Area.** R2 Resource Consultants (1998) estimated habitat-flow relationships for Chinook salmon to assess the effect of the HCP flow measures on spawning and juvenile rearing habitat in the lower Bull Run River. Using the PHABSIM model, they generated estimates of WUA for median flows up to 500 cfs for four segments of the Bull Run River. The four segments were combined into the two segments of the lower Bull Run River:  upstream and downstream of the Little Sandy River. Table 8-4 compares WUA estimates for natural flow conditions (no dams and no diversions) with estimates of HCP flows, both upstream and downstream of the Little Sandy River. For flows greater than 500 cfs, goodness-of-fit curves were used to extrapolate WUA values.

The WUA estimates for natural and HCP flows are compared using a "percentage of natural" metric. For example, if the HCP percentage of natural flow is 90 percent, the HCP median flow will yield a WUA value of 0.9 acre in a month, and the WUA value would be 1.0 acre in a month.

**Table 8-4. Comparison of Chinook Spawning Weighted Usable Area (WUA) Values in the Bull Run River**

| | Flows (cfs) | | WUA Calculated From Flow (acres) | | HCP WUA as a Percentage of Natural WUA |
|---|---|---|---|---|---|
| | Natural | HCP | Natural | HCP | |
| *Above the Little Sandy River (Upper Section)* | | | | | |
| September | 128 | 35 | 0.60 | 0.01 | 2 |
| October | 255 | 120 | 1.05 | 0.52 | 50 |
| November | 771 | 427 | 2.07 | 1.39 | 67 |
| December | 855 | 654 | 2.24 | 1.83 | 82 |
| *Below the Little Sandy River (Lower Section)* | | | | | |
| September | 152 | 55 | 0.79 | 0.39 | 49 |
| October | 304 | 166 | 1.19 | 0.82 | 67 |
| November | 927 | 608 | 1.41 | 1.40 | 99 |
| December | 1,030 | 829 | 1.41 | 1.41 | 100 |

Source: R2 Resource Consultants 1998a

**Extrapolation above 500 cfs.** Extrapolation is considered to provide conservative WUA estimates (Carlson, pers. comm., 2005), although some uncertainty exists regarding extrapolation of Chinook spawning WUA values above 500 cfs. That is, the goodness-of-fit curves used to extrapolate WUA values for Chinook spawning continue to trend upward as flows increase above 500 cfs. However, WUA values for Chinook spawning may start to decline at higher flow levels, such as those observed by R2 Resource Consultants (1998) in the segment of the Bull Run River below the Bull Run powerhouse (i.e., segment 1). In this segment, PHABSIM modeling to 2,400 cfs was possible, and the modeled WUA values for Chinook spawning start to decline at flow levels above about 700 cfs (R2 Resource Consultants 1998).

**Estimated WUA for Spawning.** The direct effects of the HCP flows on WUA for fall Chinook was difficult to determine because the City does not know whether fall Chinook currently use the lower Bull Run River for spawning. The City has collected tissue samples for genetic analysis to determine whether fall Chinook use the river, but those results are not yet known. For this analysis, the City assumed that LRW and tule fall Chinook do use the lower Bull Run River.

During the LRW fall Chinook spawning period (October–December), HCP flows will create a total WUA that is 50–100 percent of the corresponding natural flow WUA, depending on the month. During October, the HCP flows will have a negative effect on spawning, compared with natural conditions. During November and December, HCP flows will create approximately the same WUA as would be expected for natural flows in the lower Bull Run River. This analysis may, however, overestimate the negative effects on fall Chinook for two primary reasons. First, LRW fall Chinook spawning does not start until mid-October, when HCP median flows will be somewhat higher than flows for the whole of October. Second, almost all of the fall Chinook spawning occurs downstream of Larson's Bridge (RM 3.8) where the flows are higher, as indicated by the WUA estimates for below the Little Sandy River (RM 3.0) in Table 8-4.

During the tule fall Chinook spawning period (late September to mid-October), HCP flows will create a total WUA this is approximately 50 percent of the corresponding natural flow WUA.

The HCP includes a provision to reduce flows in the fall during years with critical seasons (see Measure F-2 in Chapter 7). The frequency of these reductions will be limited by the City's commitment. Critical fall flows will only occur in 10 percent of the HCP years. The City's commitment will also limit the occurrence of critical fall flows to no more than two consecutive years. If critical fall flows are triggered, the City will not release critical fall flows in the specific year when most of the resulting adult fish would return to their place of origin. When a critical fall flow year occurs, the City will not implement critical fall flows four years later regardless of whether the critical fall trigger occurs. This will reduce impacts on spawning fall Chinook because normal fall flows will be provided when the majority of adults return from a specific cohort. The age composition of the late-maturing Sandy River LRW fall Chinook run has been calculated as 7, 22, 52, and 19 percent for 2-, 3-, 4-, and 5-year-old adults, respectively (ODFW 2001). Because adults of any single cohort will primarily return in year 4, limiting reduced fall flows to a single year will minimize the impact to fall Chinook spawning.

**Estimated WUA for Rearing.** Fall Chinook juveniles rear in the lower Bull Run and emigrate in the late spring/early summer. Guaranteed minimum HCP flow from December to June is 120 cfs. The projected median flow varies from approximately 200 to 850 cfs for those months.

R2 Resource Consultants (1998) estimated that total habitat area (WUA) for juvenile Chinook reaches its maximum at approximately 350 cfs in the Bull Run River, downstream from the Dam 2 spillway (RM 5.8) to the Portland General Electric (PGE) Powerhouse (RM 1.5). Downstream of the PGE Powerhouse, total habitat area (WUA) for juvenile Chinook reaches its maximum at approximately 110 cfs. Above those maximums, the amount of habitat area remains constant as streamflow increases.

The HCP flows will create a total WUA for fall Chinook rearing that ranges from approximately 90 percent to more than 100 percent of the corresponding natural flow WUA, depending on the month (Table 8-5). Therefore, the HCP flows will minimize impacts to rearing juvenile fall Chinook.

**Table 8-5. Comparison of Weighted Usable Area (WUA) Values for Fall Chinook Juvenile Rearing in the Lower Bull Run River**

| | Flow (cfs) | | WUA Calculated from Flow (acres) | | HCP WUA as a Percentage of Natural WUA |
|---|---|---|---|---|---|
| | **Natural** | **HCP** | **Natural** | **HCP** | |
| *Above the Little Sandy River (Upper Section)* | | | | | |
| **December** | 857 | 654 | 21.16 | 19.21 | 91 |
| **January** | 782 | 611 | 20.45 | 18.79 | 92 |
| **February** | 785 | 608 | 20.48 | 18.77 | 92 |
| **March** | 780 | 606 | 20.43 | 18.75 | 92 |
| **April** | 896 | 672 | 21.56 | 19.39 | 90 |
| **May** | 755 | 563 | 20.19 | 18.33 | 91 |
| **June** | 408 | 196 | 16.83 | 14.77 | 88 |
| *Below the Little Sandy River (Lower Section)* | | | | | |
| **December** | 1,031 | 829 | 8.38 | 9.81 | >100 |
| **January** | 938 | 765 | 9.04 | 10.26 | >100 |
| **February** | 957 | 776 | 8.90 | 10.19 | >100 |
| **March** | 932 | 760 | 9.08 | 10.30 | >100 |
| **April** | 1,072 | 846 | 8.08 | 9.69 | >100 |
| **May** | 898 | 709 | 9.32 | 10.66 | >100 |
| **June** | 487 | 274 | 12.23 | 13.58 | >100 |

Source: R2 Resource Consultants

WUA values for juvenile rearing during other months were not analyzed; fall Chinook have not been observed rearing in the lower Bull Run River during the summer and fall months.

**Bull Run Peak Flows.** The City assessed effects on peak flows in the lower Bull Run River by evaluating the annual peak winter flows since Water Year 1960. This data set was used for the peak flow analysis because the USGS gauge was in another location prior to 1960. The City estimated peak winter flows in the absence of the City's water supply diversions, peak winter flows with current (2006) water diversions, and peak winter flows with estimated 2025 water diversions based on Metro's population projections. The estimated change in annual total water yield diverted for supply is expected to increase from 20 percent currently to 22 percent in 2025.

The estimated magnitude of the annual peaks with no water diversions ranged from 4,010 to 25,420 cfs, depending on weather conditions. The estimated magnitude of the annual peaks for current water demands ranged from 3,880 to 25,100 cfs. The estimated magnitude of the annual peaks for 2025 water demands ranged from 3,863 to 25,094 cfs. Differences were determined by comparing flows on individual peak flow dates. The differences between no diversions and current diversions ranged from 0.3 percent to 3.3 percent. The differences between no diversions and estimated 2025 diversions ranged from 0.6 percent to 3.7 percent.

The City also characterized each peak flow event into a return frequency category (i.e., less than 2-year event, 2–5-year event, 5–10-year event, 10–25-year event, 25–50-year event, and 50–100-year event). The flow conditions experienced in those events were applied to current water diversions and 2025 estimated water diversions. In only one case did the increase in winter season water diversions in 2025 cause a change in the return frequency category for peak events. The January 5, 1969 weather year changed from a slightly greater than 2-year event to a slightly less than 2-year event.

The City concluded from this analysis that implementation of the HCP will not significantly change the magnitude of peak-flow events in the lower Bull Run River. Peak-flow events will continue to occur with a frequency and magnitude similar to current conditions and similar to conditions that would occur without water supply diversions.

**Bull Run Scour Flows.** The HCP flow regime will reduce the risk of scour in fall Chinook redds in the lower Bull Run River, compared with historical flows. Based on a recent analysis (CH2M HILL 2003b), flows sufficient to mobilize gravels will occur less frequently and over fewer days during the HCP flows than during natural flows. The analysis focused on two time periods: primary spawning from mid-October–December and dominant egg incubation and fry emergence from January—mid-May.

A 25-year record (1980-2004) of mean daily flows in the lower Bull Run River was examined to determine the number of separate flow events large enough to mobilize spawning gravel. Those flows were contrasted with the flow regime estimated to occur under natural conditions (without City infrastructure and operations). Flows sufficient to mobilize gravels are expected to occur less frequently under the HCP flows than under natural flows. In addition, the rates of change during these peak events are likely to be lower under the HCP flows. This finding suggests that the HCP flow regime will reduce the risk of redd scour caused by peak flows compared with what would occur under natural conditions.

Even though the HCP flow measures are not anticipated to increase fall Chinook redd scour in the lower Bull Run River, the City will complete a redd scour study (see Chapter 9, Monitoring and Adaptive Management).

**Bull Run Flow Downramping.** The City's hydroelectric plant at the base of Dam 2 varies the streamflow in the lower Bull Run River during the winter and spring months when there is enough streamflow to run the facility. The current Federal Energy Regulatory Commission (FERC) license allows for a downramping rate of 2 feet per hour (2'/hour) for the lower Bull Run River, but the City is committing to a lower rate of 2 inches per hour (2"/hour) to protect juvenile salmonids.

The City has studied juvenile salmonid stranding during different downramping events in the lower Bull Run River (Beak Consultants 1999; CH2M HILL 2002). The sites selected for monitoring were the widest areas of the channel, considered most sensitive to ramping effects and stranding. Steelhead fry (about 40 millimeters [mm] average length) and yearlings (Age-1) juveniles were observed. No other salmonids were present during the stranding studies, and the City has assumed that observations of juvenile steelhead behavior are adequate for determining potential ramping rate effects. Based on the studies, a ramping rate of no more than 2"/hour was recommended for the lower Bull Run River. This rate is what the state of Oregon and others have generally recommended to protect against juvenile fish stranding (CH2M HILL 2002; Hunter 1992).

The City will minimize the risk of stranding fall Chinook juveniles by maintaining a maximum downramping rate of 2"/hour year-round for the hydroelectric powerhouse downstream of Bull Run Dam 2. All impacts from flow downramping, however, cannot be avoided due to certain circumstances beyond the control of the City.

The City conducted a year-long evaluation of downramping (Galida 2005) and determined that circumstances when the City would not meet the ramping rate occurred 0.4 percent of the time. These circumstances included natural storm flows beyond the City's control, mechanical/control system failures that are impossible to predict, and FERC mandatory testing of safety equipment. Out of a test period of approximately 8,800 hours of hydropower operation, the 2"/hour downramping rate was exceeded only for 35 hours. The exceedances occurred from mid-November through late-March, and streamflow in the lower Bull Run River was 200—12,600 cfs. Natural streamflows were quite variable and since the reservoirs were full, the downramping rate could not be controlled by the City for approximately one-third of the 35 hours. Other exceedances can be attributed to equipment testing and operator error. Overall, the City was very successful in controlling the downward fluctuation of the lower Bull Run River.

The City's commitment to a downramping rate of 2"/hour will result in minimal effects on fall Chinook. The occurrences of downramping greater than 2"/hour will rarely occur in the future, and if they do, they will happen during the winter months. This is after the fall Chinook have spawned. The redds will not be negatively affected because the streamflows are high enough to protect them. Also, there will be a very low potential for stranding juvenile fall Chinook because the higher downramps would occur only infrequently and sporadically during the late winter and early spring.

The City will continue to monitor downramping in the lower Bull Run as part of the compliance monitoring efforts (see Chapter 9).

**Little Sandy River Base Flows.** Forgoing development of the City's water rights on the Little Sandy River during the term of the HCP will help assure unimpeded natural flows on the

Little Sandy River for fall Chinook. Fall Chinook will have access to approximately 10 river miles of the Little Sandy for spawning and rearing. Flows from the Little Sandy River will also increase base flows in the Bull Run River below its confluence with the Little Sandy by 19–181 cfs, depending on the month (see Table 8-3).

### *Water Temperature*

Fall Chinook salmon utilize the Bull Run River in October and November when water temperatures are generally cool and acceptable for the species (see Figure 5-9 for the periodicity chart and Figure 8-2 for daily maximum temperatures). The species spawns in the lower Bull Run in fall, emerges from the gravel and rears in the winter and late spring, and emigrates from the Bull Run watershed by early summer.  The only time of the year when the water temperatures are too warm for the species is during the first half of October when the species is spawning.

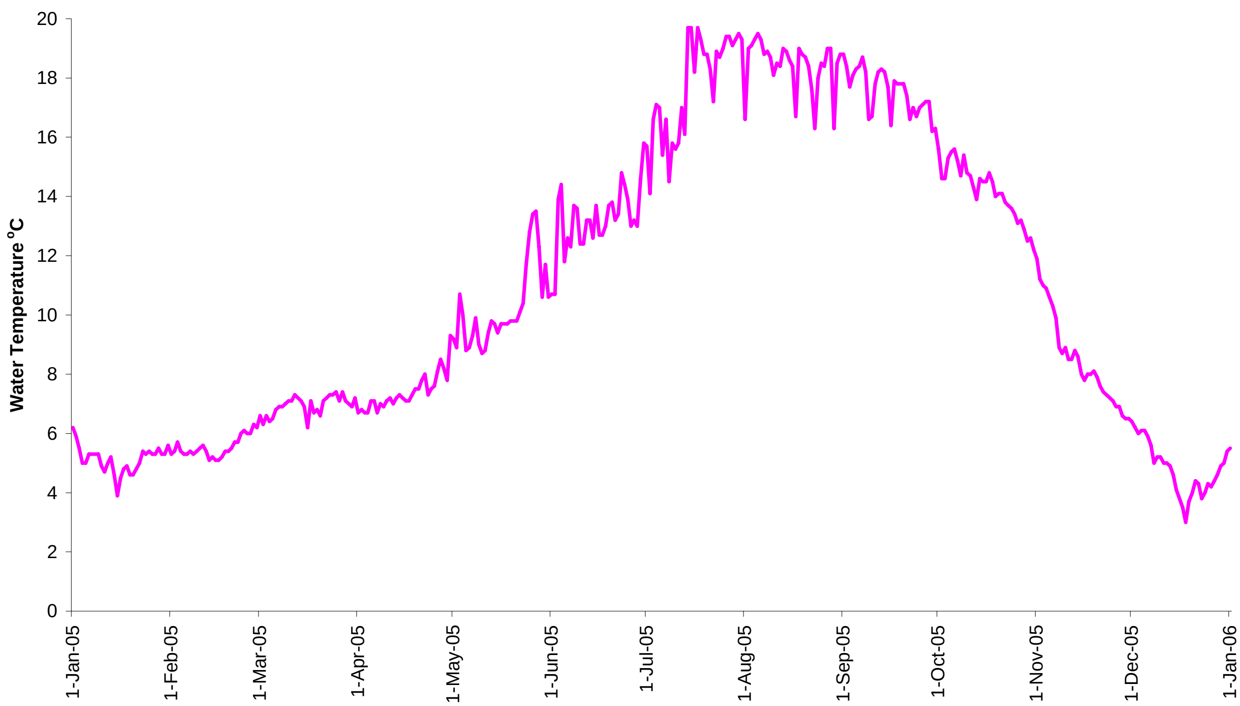


**Figure 8-2. 2005 Daily Maximum Water Temperatures for the Lower Bull Run River as Measured at USGS Gauge No. 14140000 (RM 4.7)**

Source: USGS Gauge No. 14140000 on the Bull Run River (RM 4.7)

The reference condition for water temperature is the natural thermal potential of the lower Bull Run River.  Natural thermal potential is defined by the Oregon Department of Environmental Quality (ODEQ) in the Sandy River Total Maximum Daily Load (TMDL) (2005) as the water temperatures that would occur in the Bull Run River if there were no dams or diversion.  The City, in conjunction with ODEQ, developed a method to determine the natural thermal potential of the lower Bull Run River and found that the current temperature regime of the Little Sandy River is a good surrogate for the Bull Run. (See temperature measures T-1 and T-2 in Chapter 7 for more details.)

**Pre-infrastructure Water Temperature Effects.** The City plans to make significant infrastructure improvements at Dam 2 to meet the natural thermal potential of the lower Bull Run River. However, prior to completion of the infrastructure improvements, water temperatures in the lower Bull Run River during the first half of October will exceed those preferred for spawning fall Chinook (see Figure 8-3).

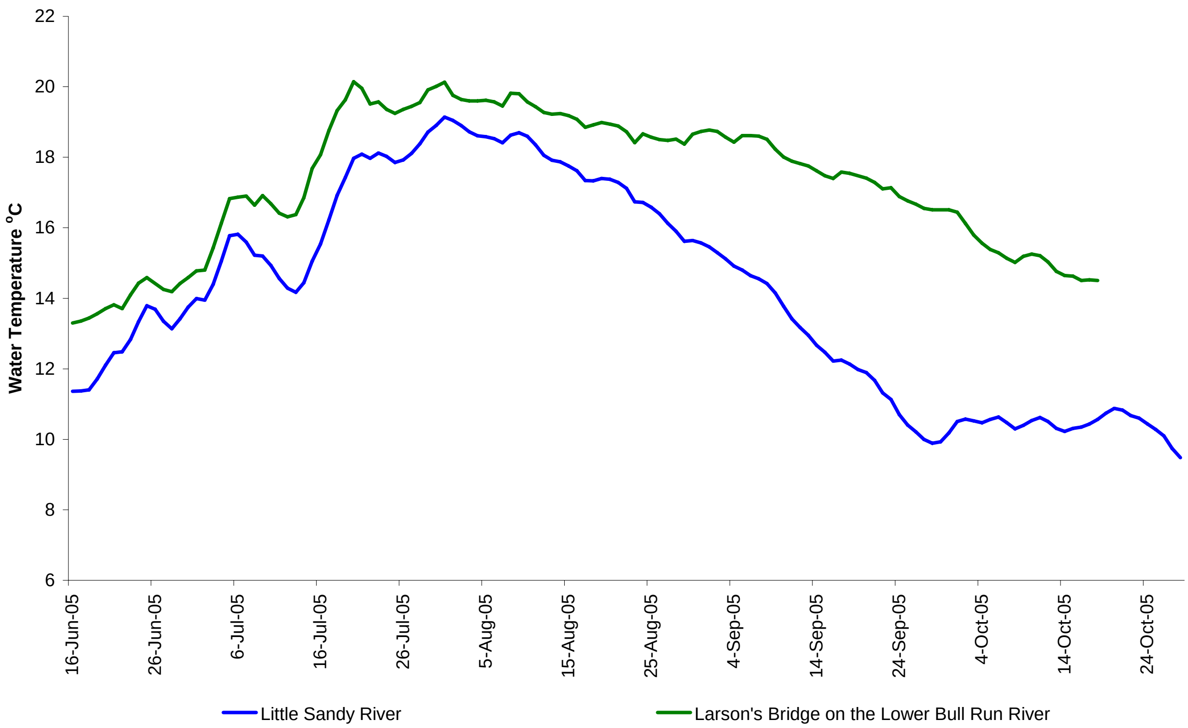


**Figure 8-3. 7-Day Maximum Average Water Temperatures for the Little Sandy and Lower Bull Run Rivers, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and USGS Gauge No. 14140000 on the Bull Run River (RM 4.7).

Before the infrastructure changes, the City will continue to carefully manage the amount of cool water in the reservoirs for downstream flow releases. Figure 8-3 indicates the water temperature performance that the City will be able to achieve in the first years of the HCP. The water temperature of the lower Bull Run River, expressed at Larson's Bridge in Figure 8-3, would be approximately 14—16 °C for the first two weeks of October. That is slightly higher than ODEQ's water temperature criterion of 13 °C for spawning salmonids. Within five years of the start of the HCP, the infrastructure changes at Dam 2 will be completed and the natural thermal potential of the Bull Run River will be met. The pre-infrastructure water temperature effects should be minimal because the water temperature will not be significantly higher than ODEQ's criterion and these conditions should only last approximately five years.

**Post-infrastructure Water Temperature Effects.** The City used the CE-QUAL-W2 water quality model to predict natural condition stream temperatures in the lower Bull Run River (City of Portland 2004). The model predicted that maximum stream temperatures would occur at Larson's Bridge (RM 3.8) in the lower Bull Run River. City staff and ODEQ staff evaluated modeling results and empirical data and concluded that natural stream temperatures in the lower Bull Run River could be estimated using the stream temperature of the Little Sandy River (see Figure 8-4)

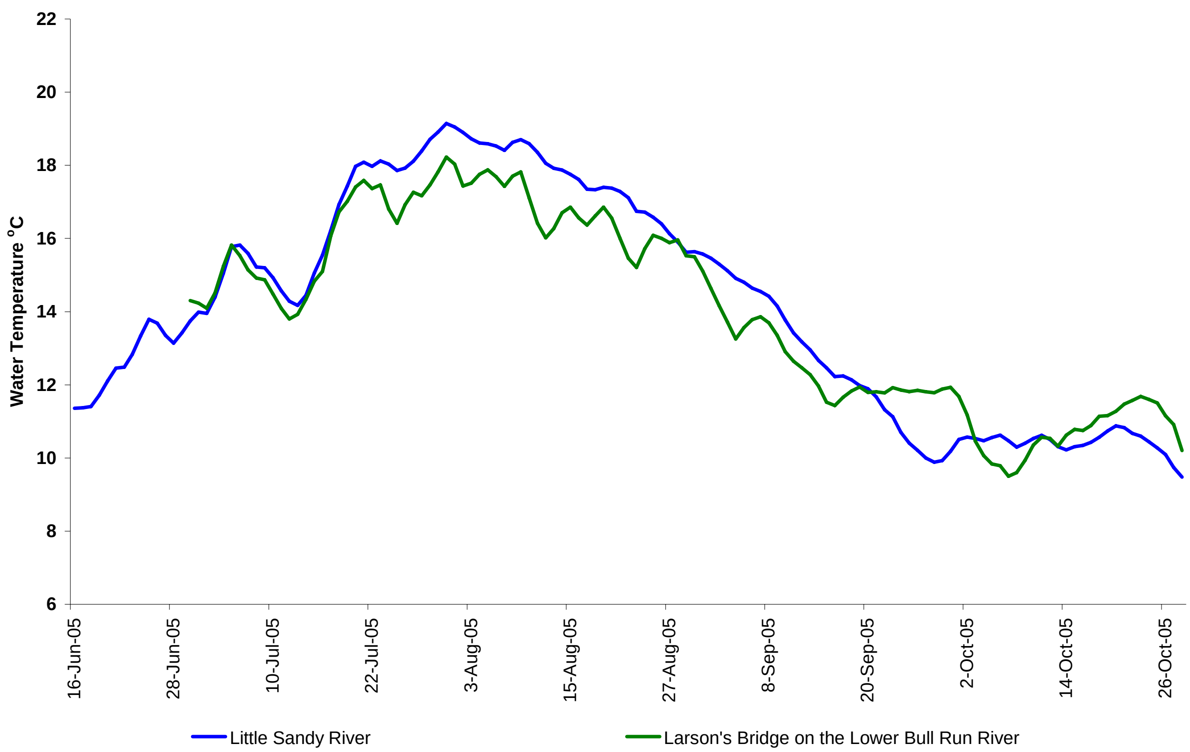


**Figure 8-4. Comparison of Actual 7-Day Maximum Water Temperatures for the Little Sandy Rivers with Predicted 7-Day Maximum Average Temperatures for the Lower Bull Run River, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and CE-QUAL-W2 Modeled Temperatures (February 2006)

The summer and early fall water temperatures in 2005 shows that water temperatures at Larson's Bridge are generally lower than temperatures in the Little Sandy but are within approximately 1 °C (see Figure 8-3). ODEQ has established water temperature criteria for the Larson's Bridge location under the authority of the Clean Water Act (CWA) and the Sandy Basin TMDL (see Measure T-2 in Chapter 7).

After completion of the infrastructure improvements, the flow and temperature management measures in the HCP will closely approximate the natural thermal potential and will reduce impacts to fall Chinook spawning. Additional details are provided in Chapter 7 and in Appendix G, Temperature Management Plan.

***Large Wood***

Large wood is removed from the upper end of Reservoir 1 to protect the downstream water supply dams from damage. The U.S. Forest Service (USFS) owns this wood because it is transported by tributaries from national forest land. Since this wood is not allowed to travel down the lower Bull Run River, a small amount of beneficial habitat is potentially lost for fall Chinook. The lower Bull Run River is, however, a high-order steep stream and is not likely to trap and store large wood. Photographs taken of the lower Bull Run in the late 1890s, before the dams and water diversions were constructed, show little large wood in the channel. The lower river is probably a transport reach for large wood.

The channel of the lower river is dominated by bedrock and boulders. This channel roughness supports diverse habitats, including about 27 percent pool habitat. The presence of this pool habitat suggests that large wood is not important for pool formation, and the addition of large wood would provide only a minor increase in pool habitat.

The City does not plan to artificially place large wood in the lower Bull Run River above Larson's Bridge because of concerns about the vulnerability of water supply infrastructure (i.e., conduit bridge crossings). The City will let natural recruitment of large wood occur downstream of Larson's Bridge. Trees that fall naturally will be left in place to modify the stream channel as long as the water conduits and bridges are not threatened. This large wood could slightly improve habitat conditions for fall Chinook by reducing the overall grain sizes and creating pools in localized areas in the lower 3.8 miles of the lower Bull Run River.

***Spawning Gravel***

The two Bull Run dams interrupt bedload and gravel movement to the lower Bull Run River, resulting in reduced spawning habitat for fall Chinook salmon and other species. The estimated historic gravel supply rate varied from 30 to 1,000 cubic yards (CH2M HILL 2003b). The City will place approximately 1,200 cubic yards each year for the first five years and 600 cubic yards per year thereafter (see Measure H-1 in Chapter 7). The gravel replacement rate will be higher than the estimated natural accumulation for the first five years of the HCP. Placement of gravel in the lower Bull Run River under the HCP will significantly improve the spawning conditions for fall Chinook and minimize City impacts.

Photo courtesy of Bonneville Power Administration.

*Access*

Fall Chinook were first blocked from the upper Bull Run River in 1921 by construction of the Diversion Dam (approximately RM 5.9). The dam diverted Bull Run water into conduits to supply the greater Portland metropolitan area. In 1964, as part of Dam 2 construction, a rock weir at RM 5.8 was built to create the Dam 2 plunge pool. This pool provides energy dissipation below the Dam 2 spillway. The rock weir is now the upstream limit for fall Chinook in the Bull Run watershed. Fall Chinook distribution is also limited in the Little Sandy River due to PGE's diversion of water to Roslyn Lake and the Little Sandy Dam at RM 1.7.[2]

Fall Chinook access will remain blocked by the rock weir at RM 5.8 during the term of the HCP. Continued operation of the City's water supply will block access for fall Chinook to approximately 10.5 miles of the upper Bull Run River. Of these mainstem Bull Run River stream miles, only 1.3 miles are free-flowing river, and 9.2 river miles are inundated by City reservoirs.

When PGE removes the Little Sandy Dam, fall Chinook will have access to an additional 5.6 miles of the mainstem Little Sandy River, and possibly 2.0 additional miles of tributary streams. The City's agreement to maintain flows for fish in the Little Sandy (see Measure F-4, Chapter 7) will help retain habitat benefits from this renewed access to the historical habitat for fall Chinook.

[2] The Little Sandy Dam is scheduled for decommissioning and removal in 2008. See Chapter 4, section 4.1.5, Water Quantity and Water Rights, for more information.

### *Riparian Function*

The City owns land along 5.3 miles of the lower Bull Run River (1,650 acres). The City's lands represent 82 percent of the riparian corridor below Dam 2. Managing these lands to protect riparian habitat will improve habitat for fall Chinook (see Measure H-2 in Chapter 7). Approximately 30 percent of the riparian corridor along the lower river is in late-successional (late-seral) timber that can provide immediate large wood recruitment to the channel. Further, 80 percent of the riparian corridor is of mid- to late-seral age that will provide wood to the channel at an increasing rate over the next 10 to 70 years (Cramer et al. 1997).

Analysis of shading in the lower Bull Run River indicates that riparian vegetation currently intercepts 40 to 60 percent of the total solar radiation that potentially could reach the water surface (Leighton 2002). This shading provides a substantial benefit by maintaining lower water temperatures. This shading benefit become greater over time as the vegetation continues to mature. The mature vegetation in the lower Bull Run combined with the temperature measures (infrastructure changes to the intake towers and temperature management) will closely approximate natural water temperatures and reduce the effects of water system operations on fall Chinook.

### *Total Dissolved Gases*

Oregon's Water Quality Standards state that TDG levels should not exceed 110 percent of saturation, unless flows exceed the ten-year, seven day average flood (7Q10) flow for the site [OAR 340-041-0031]. The 7Q10 flow for the lower Bull Run River is 5,743 cfs. The City has monitored all water system structures, valves, or turbines that could elevate TDG levels since 2005, and has determined that fall Chinook are unlikely to be adversely affected by TDG levels in the Bull Run River. A 55-foot deep stilling pool at the base of the Dam 2 spillway is the site most likely to produce TDG levels that could affect fall Chinook. This location, however, is upstream of the range of anadromous fish. Monitoring by the City indicates that elevated levels of TDG quickly decrease as water passes over the rock weir below the stilling pool (RM 5.8). The City has never measured TDG levels that met or exceeded 110% in the anadromous portion of the Bull Run River, unless the 7Q10 flow was also exceeded. TDG levels further dissipate between the rock weir and Larson's Bridge, about 1 mile downstream (RM 4.7). Almost all of the fall Chinook observed in the lower Bull Run River were downstream of Larson's Bridge (Strobel 2007a, Clearwater BioStudies 1997, 2006; ODFW 1998; Beak Consultants 2000a,b). Fall Chinook are probably not impacted by TDG levels in the Bull Run River. The City, however, will continue to monitor TDG levels in the Bull Run as described in Chapter 9 and Appendix F, Monitoring Plans and Protocols.

**Summary of Effects on Fall Chinook in the Lower Sandy River from Bull Run Water Supply Operations and HCP Measures**

The City identified four types of effects that water supply operations could have on fall Chinook habitat in the lower Sandy River.

- Base flows in the lower Sandy will be reduced by continued water supply operations in the Bull Run, but the weighted usable area for fall Chinook spawning habitat will be increased.
- Flow downramping effects in the lower Sandy will be avoided.
- The HCP will have small but beneficial effects on water temperatures in the lower Sandy.
- The HCP will also minimize the impact of removing large wood from the lower Bull Run by adding large wood directly into the lower Sandy.

Overall, the City's HCP measures for the Bull Run River will have positive effects on fall Chinook habitat in the lower Sandy River. Table 8-6 summarizes the habitat effects of the Bull Run measures in the lower Sandy.

Table 8-6. Effects of the Bull Run Measures on Lower Sandy River Habitat for Fall Chinook[a]

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base Flows | Natural Sandy River base flows | Flows after implementation of the HCP will be more than 80% of natural base flows.[b] |
| Weighted Usable Area | Natural Sandy River base flows | Flows will increase habitat for spawning by up to 20 percent.[c] |
| Flow Downramping | Protective downramping rate: 2"/hour | The City's water supply operations will have minimal effects on fish stranding due to downramping. |
| Water Temperature | ODEQ standard: natural thermal potential | The City's HCP measures will probably have small water temperature benefits. |
| Large wood | Natural wood accumulation | Removal of large wood from the reservoirs reduces the amount of large wood loading to downstream Sandy River reaches and reduces channel complexity.<br>City measures will increase large wood levels and habitat diversity, minimizing adverse effects of Bull Run operations in the Sandy River below the Bull Run confluence. |

[a]For the list of conclusions about the habitat effects of all HCP measures on fall Chinook, see page 8-38.

[b]Based on flow data from 1985–2001, natural base flows were reduced by 4–19 percent (CH2M HILL 2002).

[c]Based on flow data from 1985–2001, habitat for spawning was increased by 2–18 percent.

### Habitat Effects in the Lower Sandy River from the Bull Run Measures

The EDT database and model were used to identify limiting factors having the greatest impact on fall Chinook in the lower Sandy River below the confluence with the Bull Run River. The factors identified were food, habitat diversity, harvest, flow, channel stability, competition from the same species, predation, water temperature, pathogens, and sediment. Of these 10 factors, three are potentially affected by water supply operations in Bull Run: flow, water temperature, and large wood recruitment (as a subfactor in habitat diversity). The other seven factors are not directly related to water supply operations.

#### *Streamflow*

A flow effects analysis was completed for Chinook salmon in the lower Sandy River below the Bull Run (CH2M HILL 2002). This analysis focused on the potential effects of the City's Bull Run operation on base flows and on flow fluctuations (ramping). The analysis used Bull Run flows from 1985 to 2001, which are lower than the HCP flows as described in Chapter 7.

**Base Flows.** The City compared the WUA and monthly flow amounts without City operations to the WUA and monthly flows during the 1985 to 2001 period. City operations from 1985 to 2001 reduced base flows in the lower Sandy River by 4 percent to 19 percent (depending on month), but increased habitat for Chinook spawners in the lower Sandy River by about 2 percent to18 percent October through December. October to December is the prime spawning period for LRW fall Chinook. Available habitat for Chinook fry (expressed as WUA) was 2 percent lower in April but about 0.7 percent to 3 percent higher during February, March, and May.

The CH2M HILL analysis (2002) concluded that fall Chinook spawning and rearing in the lower Sandy River would not be adversely affected by the City's operations, even at lower flows than described in Measure F-1 in Chapter 7. R2 Resources Consultants (1998) similarly concluded that flow enhancement in the lower Bull Run River would have little or no beneficial effect on spawning and rearing Chinook salmon in the lower Sandy River.

**Downramping.** The CH2M HILL analysis (2002) indicates that a downramping rate of 2"/hour would eliminate juvenile salmonid stranding in the lower Bull Run River. Given the analysis above about base flow effects, the HCP downramping measure is also expected to minimize any potential juvenile stranding effect in the lower Sandy River.

#### *Water Temperature*

Both ODEQ's and the City's water temperature modeling results indicate that water temperatures in the lower Sandy River reaches are in a state of relative equilibrium. City water supply operations have little influence on heating or cooling of the lower Sandy River. This conclusion is supported in the Sandy River Basin TMDL report (ODEQ 2005).

Even though the City's operations in the Bull Run will not affect water temperatures lower in the Sandy River, some of the City's offsite conservation measures will probably have small water temperature benefits.

### *Large Wood*

Removal of large wood from the Bull Run reservoirs reduces the amount of large wood loading to downstream Sandy River reaches and reduces channel complexity for fall Chinook. To mitigate for this impact, the HCP includes several large wood measures in the lower Sandy River (see Measures H-4, H-11, H-12, and H-13 in Chapter 7). Installing large log jams (Sandy, RM 0 – RM 8) will increase habitat diversity for fall Chinook. Easements located in prime fall Chinook spawning and rearing areas will also improve riparian conditions in the Sandy River. None of the easement areas have riparian zones that are in natural condition and as these riparian areas mature, large wood recruitment will increase. Collectively, these measures will minimize any adverse effects of Bull Run operations on habitat complexity for fall Chinook in the lower Sandy River.

## Habitat Effects in the Columbia River from Use of Groundwater

The City will use groundwater from the Columbia South Shore Well Field, in conjunction with the Bull Run River flows, to provide the total amount of water needed to meet water supply demands and the HCP flow commitments.  The Columbia River is located adjacent to the well field, so the City analyzed the effect groundwater use might have on flows in the Columbia River.

As context, only one instream flow commitment has been established for the lower Columbia River to maintain the persistence of Endangered Species Act (ESA)-listed species. This requirement is the Federal Columbia River Power System's (FCRPS's) minimum flows of roughly 125,000 cfs below Bonneville Dam, unless competing priorities preclude it (U.S. Army Corps of Engineers [USCOE] et. al. 2006).  These minimum flows are increased by contributions from the Sandy and Washougal rivers before arriving at the Glenn Jackson Bridge (I-205 bridge), approximately 14 miles west of the mouth of the Sandy River.

The well field has an estimated sustainable capacity of approximately 85 million gallons per day (mgd), which is equivalent to approximately 130 cfs.  The actual amount and duration of pumping will vary according to the weather and supply conditions, but typically the amount pumped per day would be significantly less than the full capacity. The well field draws on four regional alluvial aquifers.  Recharge for these aquifers occurs as far south as the Boring Hills (Hartford and McFarland 1989). These aquifers generally discharge into the Columbia River.

As a simplifying worst-case assumption for this analysis, the City assumed that 85 mgd would be pumped from the well field and that this amount would be drawn into the aquifers from the Columbia River.  (This is a significant overestimate because the water pumped would actually be drawn primarily or completely from the aquifers themselves and not from the river into the aquifers.)  The assumed flow into the aquifers would reduce the assumed flow available in the Columbia River for fish.

If the City's groundwater pumping were to result in a 130 cfs reduction in Columbia River flows, that reduction would be at most 0. 1 percent of the total river flow (based on the 125,000 cfs minimum flows mentioned above).  To put this reduction in perspective, the typical margin of error on measured flows for the Columbia River is +/- 10 percent (see for example the gauge at the Columbia River at The Dalles, USGS 2003). This measurement error is significantly larger than the estimated flow reduction due to groundwater use. In addition, the mainstem Columbia River has tidal fluctuations that average approximately 1.7 feet (data from USGS Gauge No. 14144700). This natural daily change in river stage is many orders of magnitude greater than any potential reduction of Columbia River flows due to the City's use of groundwater. The City's conclusion is therefore that use of the Columbia South Shore Well Field as a means to enable the HCP flow commitments in the lower Bull Run River, will have a negligible influence on the Columbia River base flows and associated habitat for fall Chinook salmon migrating in the river.

### Summary of Effects in the Sandy River Basin from the HCP Offsite Measures

This HCP includes offsite measures in fall Chinook production areas in the Sandy River Basin to mitigate effects that cannot be avoided in the lower Bull Run River.[3] HCP measures in the lower Sandy River mainstem to benefit fall Chinook include reconnecting a side channel, reestablishing the river mouth, improving riparian conditions, and adding engineered log jams. The HCP also includes measures to place large wood and enhance riparian conditions in Gordon and Trout creeks. Measures to benefit fall Chinook salmon in the middle Sandy River watershed include riparian easements and improvements, and large wood placement.

The effects of the offsite measures for fall Chinook are as follows:

- Reduced risk of peak flow displacement, increased cover from predators, increased rearing habitat, and improved habitat diversity will benefit juveniles in the lower and middle Sandy River watersheds.
- Holding adults will benefit from the improved habitat diversity in the middle Sandy River and Gordon Creek.
- Increased pools in Gordon Creek will provide key habitat for rearing juveniles.
- Trout Creek improvements will improve spawning and egg incubation.

Details of the specific improvements in fall Chinook habitat that will result from the offsite measures are described in this chapter and in Appendix E. Overall, the City's offsite conservation measures will improve habitat for fall Chinook in the lower and middle portions of the Sandy River Basin.

[3] Effects in the lower Bull Run River for fall Chinook include reduced base flows and weighted usable area and blocked access to the upper Bull Run River. Chapter 5 includes a detailed description of the impacts for this species.

## Habitat Effects in the Sandy River Basin from the HCP Offsite Measures

The City's HCP includes 30 offsite habitat conservation measures. Most of these actions address environmental problems affecting the production of more than one species. This analysis describes the effects of the HCP measures on fall Chinook. Effects are described by watershed and address fall Chinook life stages and limiting factors. (See Chapter 5 for additional information on the fall Chinook population in the Sandy River Basin and the habitat factors that limit production.)

### *Little Sandy River*

The City's water supply operations do not affect the Little Sandy River because it is a tributary to the lower Bull Run River downstream of the City's dams and diversion. The City's large wood habitat conservation measure for the Little Sandy River was selected to improve habitat diversity for spawning and rearing salmonids, but the primary focal species was not fall Chinook.

The City will place large wood in the Little Sandy River (see Measure H-3 in Chapter 7), which will slightly increase channel complexity and gravel sorting for fall Chinook and other fish species.  The City believes that the large wood measure will slightly benefit fall Chinook spawning because the large wood will trap suitable spawning gravel.

### *Lower Sandy River Watershed*

Fall Chinook primarily spawn in the mainstem Sandy River up to the Marmot Dam site.[4] If early season rainfall occurs, fall Chinook use the lower portions of Gordon, Trout, and Cedar creeks. Gordon and Trout creeks are utilized by the Late Bright portion of the wild fall Chinook run (Sandy River Basin Partners [SRBP] 2005).

The HCP offsite measures were selected in fall Chinook production areas with the intent to mitigate effects that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The analysis also considers beneficial effects for fall Chinook that are likely to result from measures designed primarily for other species.

The City will implement measures in the lower Sandy River watershed to benefit fall Chinook, including reconnecting a side channel, reestablishing the river mouth, restoring the riparian area, and adding engineered log jams on the lower Sandy mainstem, as well as placing large wood and making riparian enhancements in Gordon and Trout creeks. A detailed description of each measure and the affected reaches is available, by watershed, in Chapter 7.

Table 8-7 lists the reaches affected by HCP measures planned in the lower Sandy River watershed and provides a summary of the expected habitat benefits in each reach (see also tables in Appendix E for percentages for reference condition and post-implementation values).

[4] Marmot Dam was decommissioned by PGE and removed in July of 2007.

**Table 8-7. Habitat Benefits for Fall Chinook in the Lower Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Beaver 1A | Riparian function | Improvement |
| | Large wood | Increase |
| Gordon 1A | Fine sediment in gravel patches | Decrease |
| | Backwater pools | Increase |
| | Large-cobble riffles | Decrease |
| | Pool habitat | Increase |
| | Pool-tail habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 1 | Artificial confinement | Reduction |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Large wood | Increase |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Trout 1A | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

The riparian protection/enhancement projects in the lower Sandy mainstem reaches will increase large wood, improve riparian function, decrease confinement in Sandy 1, and slightly improve water temperature, benefiting juveniles and holding adults. Additional large wood will help stabilize the stream channel, lessen peak flow displacement risks, and provide escape cover from predators for fry. Increased riparian function should also lessen impacts attributed to limited food availability. Reopening the historic mouth of the Sandy River is also likely to aid adult passage and create additional rearing habitat for fall Chinook.

Key habitat for juveniles will increase in Gordon Creek as large wood increases the amount of pools, backwater pools, and pool tail-outs for juveniles and holding adults. Gravel retention created by the newly installed log structures will also improve channel stability. A riparian enhancement project on the lowermost reach will stabilize crumbling banks and filter out surface inputs of sediment to spawning substrate. The additional spawning habitat and the improvement in riparian function should improve habitat for holding adults.

Large wood measures in Trout Creek will directly increase the stability of gravel bars, thus aiding incubation.  Spawning habitat will also likely improve because the large wood will increase sorting and storage of suitably sized gravels for fall Chinook.

***Middle Sandy River Watershed***

Most of the middle Sandy mainstem is carved through bedrock in a deep, steep-walled gorge. The main impact to habitat quality in the mainstem middle Sandy has been the Marmot Dam, which is outside the authority of the City and was decommissioned in July 2007.

The Marmot Dam inflow reach (Sandy 6) provides exceptional spawning and rearing habitat with a low gradient, pools, riffles, side channels, and relatively abundant cobble/gravel substrate and large wood. Fall Chinook, however, had not been observed going over the Marmot Dam (SRBP 2005), but the distribution of the species may increase dramatically once the dam has been removed and the natural flow pattern is returned to the Sandy River.

The portion of Cedar Creek that is accessible supports natural fall Chinook productivity. A weir constructed in the early 1950s partially blocks fish passage approximately 0.5 mile upstream from the mouth of Cedar Creek (SRBP 2005).

The HCP measures for the middle Sandy River were selected with the intent to mitigate effects that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The analysis also considers beneficial effects for fall Chinook that are likely to result from measures designed primarily for other species.

The City will implement measures to benefit fall Chinook salmon in the middle Sandy River watershed, including riparian easements and improvements and large wood placement. The City will also purchase available water rights in Cedar Creek from willing landowners (see Measure F-5, Chapter 7) to improve habitat conditions for fall Chinook and other species. A detailed description of each measure and the affected reaches is available, by watershed, in Chapter 7.

Table 8-8 lists the reaches affected by HCP measures planned in the middle Sandy River and provides a summary of the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-8. Habitat Benefits for Fall Chinook in the Middle Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Cedar 1 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Minimum water temperature | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| Sandy 3 | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

The riparian easements and improvements in the middle Sandy River and Cedar Creek will protect intact portions of the riparian corridor, improve the arboreal species composition (by culling hardwoods and planting conifers), and allow for related habitat improvements (such as large wood recruitment and decrease in temperature) to occur over time. Large wood placement will increase channel stability to some degree for all life stages, decrease the risk of displacement by peak flows, and improve habitat diversity for juveniles and holding adults. In Cedar Creek, after fish passage is provided at the Oregon Department of Fish and Wildlife's (ODFW's) weir, large wood placement above the weir will increase key habitat for fry.

Currently, fall Chinook use only the lowest reach of Cedar Creek. The City does not yet know how much flow might be returned to Cedar Creek from purchasing existing surface water rights, and therefore the benefits of the action can only be generally described as an increase in base flows over existing conditions as a result of the City's commitments.

The City did not assume that any habitat benefits for fall Chinook salmon from the HCP conservation measures would occur upstream of the Marmot Dam site. The Sandy River Basin Agreement Technical Team (SRBTT) determined that the current fall Chinook distribution in the Sandy River Basin was up to the dam site. However, fall Chinook can access the upper Sandy Basin now that the dam has been removed. Since the accrual of benefits after dam removal was speculative at the time benefits were calculated, the City did not include them as part of this effects analysis.

### Summary of Population Effects and VSP Parameters

Implementation of the HCP will significantly improve habitat for the Sandy River population of fall Chinook salmon. The VSP parameters for productivity, diversity, and abundance are projected to increase by 11–18 percent with the City's HCP commitments. These projected increases in the VSP parameters are conservative because they do not include benefits to fall Chinook that will also be derived from projects supported by the City's $9 million Habitat Fund (see Measure H-30, Chapter 7).

### Population Effects and VSP Parameters

The HCP habitat conservation measures were designed to minimize and mitigate the effects of the Bull Run water supply operations on fall Chinook, as well as the other covered species. This section describes estimated effects of the City's HCP on the overall Sandy River fall Chinook population using parameters established in the NMFS recovery planning process, specifically the work of the Lower Columbia River Technical Recovery Team (LCR-TRT).

Sandy River fall Chinook are part of the Lower Columbia Evolutionarily Significant Unit (ESU) (Cascade Zone). Sandy River fall Chinook are considered by the LCR-TRT and the LCRFRB (LCRFRB 2004) to be a primary population for recovery in the Lower Columbia ESU. Primary populations are those that need to be restored to "High" or "Very High" viability levels in order to recover the species. Sandy River fall Chinook have been identified (LCRFRB 2004) as needing to be restored to a "High" viability level, or 95–99 percent likelihood of persistence.

The EDT model was used to estimate the benefits for fall Chinook that are likely to result from implementing the HCP. Current habitat conditions were established as the reference condition for this analysis. Population results that would result from implementation of the HCP were compared to population results that are representative of current habitat conditions.

Although the model results are not absolute predictions of fish abundance, they do provide a relative comparison of the expected salmon population performance based on the best available science. The inputs to the model represent a combination of site-specific empirical habitat data and, where that data was not available, the professional opinion of biologists intimately familiar with the Sandy River ecosystem. (See Appendix D for an explanation of the theory and information structure as well as the habitat rating rules for the EDT model.)

The HCP measures are expected to result in substantial increases in all of the fall Chinook VSP parameters.[5] Increases in productivity, diversity, and abundance are presented in Table 8- 9. These estimates represent increases over what could be expected to result from current habitat conditions in the Sandy River Basin. Improvements in the species spatial structure are discussed in the following text. NMFS (in coordination with ODFW) has not yet developed a recovery plan for the Lower Columbia ESU or set clear objectives for each VSP parameter, so the significance of these improvements is not yet known.

**Table 8-9. Increases for Fall Chinook Expected Due to HCP Implementation[a]**

| | Productivity | Diversity | Abundance |
|---|---|---|---|
| **Without Cedar Creek Weir Removal** | 11% | 18% | 12% |
| **With Cedar Creek Weir Removal** | 11% | 18% | 12% |

Source: EDT model run April 17, 2007

[a]Estimates do not include benefits from removing the Marmot Dam on the Sandy River.

### *Productivity*

The estimated 11 percent increase in productivity results from increased quality of stream habitat in river reaches located below the Marmot Dam site and in the lower Bull Run River. Increased productivity allows the population to rebound quickly from periods of either low seawater or freshwater survival that depress population size.

[5] Modeling results for fall Chinook represent both the fall and late fall races.

***Diversity***

The 18 percent increase in life history diversity represents improvements in habitat conditions over both time and space. The flow regime measures for the lower Bull Run River create habitat conditions that will allow both spawn timing and juvenile rearing to occur over a longer time frame. Improved habitat conditions in the mainstem Sandy River and Gordon Creek also increase life history diversity.

***Abundance***

The estimated 12 percent improvement in adult fall Chinook abundance in the Sandy River Basin results from the increases in productivity and diversity. Increased abundance reduces extinction risk for the population. In addition, with the removal of Marmot Dam , fall Chinook are expected to colonize mainstem Sandy River habitat upstream. Juvenile fish produced upstream of Marmot Dam will also be able to utilize the lower Sandy River for rearing. The habitat improvements from the HCP measures will help leverage the increased juvenile fall Chinook survival expected to occur after the Marmot Dam removal.

The higher abundance will result in increased ecological benefits. Salmonids improve both their physical and biological environments through various mechanisms. For example, adult spawners reduce fine sediment concentrations in gravels, and their carcasses provide a food source for other aquatic and terrestrial species.

Although the LCR-TRT has not yet established recovery goals for Sandy River fall Chinook, others have indicated that the Sandy River Basin has the potential to produce up to 10,200 adults (LCRFRB 2004). The City's HCP makes a significant contribution toward achieving this objective.

***Spatial Structure***

The viability of a salmon population depends not only on the population's productivity, abundance, and diversity, but also on its spatial structure (McElhany et al. 2000). The more watersheds in a basin that contain large numbers of spawners, the less likely that catastrophic events such as landslides, volcanic eruptions, and human-caused disasters will result in the extinction of the population.

Historically, the vast majority of Sandy River fall Chinook spawned in the mainstem Sandy River and in larger tributaries from its mouth to near its confluence with the Salmon River. Currently, fall Chinook are limited to the mainstem Sandy River below Marmot Dam, the lower Bull Run River, and near the mouths of small tributaries such as Gordon, Trout, and Cedar creeks. The City's action will not increase the distribution of fall Chinook in the Sandy River Basin but will improve habitat conditions for the species in primary spawning areas.

The City's actions are designed to improve riparian conditions, increase the amount of large wood, and increase streamflow for four of the watersheds where fall Chinook historically ranged. In addition, measures implemented in streams such as the Salmon River and Zigzag River may provide additional benefits to fall Chinook if this species recolonizes those areas after the removal of Marmot Dam. Because the combination of HCP measures targets all of the spatial structure objectives, the City's plan addresses all three of the spatial diversity objectives and will thereby help reduce the extinction risk for fall Chinook.

Table 8-10 summarizes the population effects of the HCP measures on fall Chinook by the VSP parameters of abundance, productivity, diversity, and spatial structure.

**Table 8-10. Effects of the HCP Measures on Sandy River Basin Fall Chinook Populations by Viable Salmonid Population (VSP) Parameters**

| VSP Parameter | Reference Condition | Effect of Conservation Measures |
|---|---|---|
| Abundance | Current habitat conditions | Abundance for the Sandy River population is projected to increase by 12%. |
| Productivity | Current habitat conditions | Productivity for the Sandy River population is projected to increase by 11%. |
| Diversity | Current habitat conditions | Diversity for the Sandy River population is projected to increase by 18%. |
| Spatial Structure | Current habitat conditions | HCP will increase spawner abundance in the Bull Run, lower Sandy, and middle Sandy river watersheds, the core of current fall Chinook production. Increased adult abundance in multiple watersheds will increase spatial diversity and reduce extinction risk. |

Sources: EDT model run April 17, 2007 for abundance, productivity, and diversity percentages; for spatial structure assessment, Kevin Malone, personal comm. 2006

### Summary of Population Effects

The projection of adult fall Chinook abundance under the City's HCP is greater than the modified historical Bull Run condition scenario established for the Bull Run watershed.[6] This comparison indicates that the HCP will produce enough beneficial habitat changes for fall Chinook salmon to offset impacts caused by the City's water supply operations in the Bull Run.

### Population Effects and Benchmark Comparison of Fish Abundance

The introduction to this chapter describes a benchmark scenario the City developed to compare results of the HCP with a reference condition (see Section 8.1.1). The EDT model was used to generate the estimated abundance of fall Chinook and to compare the benchmark against the benefits of the City's HCP measures. The City believes that the Modified Historical Bull Run Condition benchmark estimate represents generous assumptions and that the HCP estimate is an underestimate of probable HCP results (as described in Section 8.1.1).

[6] See the subsection Sandy Basin Population Effects under Section 8.1.1 for an explanation of the benchmark comparison of fish abundance in the Bull Run watershed.

Model results indicate that the HCP measures would improve habitat for fall Chinook to match or exceed the production potential of the Modified Historical Bull Run Condition scenario (Table 8-11).

**Table 8-11. Model Results for Fall Chinook Abundance: Modified Historical Bull Run Condition Compared with HCP Measure Implementation[a]**

| Scenario | Adult Abundance |
|---|---|
| Modified Historical Bull Run Condition | 6,669 |
| HCP Measures Without Cedar Creek | 6,913 |
| HCP Measures With Cedar Creek | 6,913 |

Source: EDT model run April 17, 2007
[a]Estimates do not include benefits from removing the Marmot Dam on the Sandy River.

The City believes these results help demonstrate that the HCP will provide the benefits for fall Chinook necessary to meet the ESA Section 10 requirements. However, the City does not propose to use EDT population estimates as an enforceable performance measure for fall Chinook. The City's HCP is purposefully habitat-based. It is designed using measurable objectives, monitoring, and an adaptive management trigger that all relate to habitat condition, as described in other chapters of this document.

Note: The analysis in this HCP does not include any benefits for fall Chinook above the Marmot Dam site.

### Conclusions about the Habitat Effects of HCP Measure Implementation

- **Effects in the Lower Bull Run River.** All of the HCP measures in the lower Bull Run River will benefit fall Chinook salmon. These measures avoid or minimize ongoing City impacts in the Bull Run River (as described in Table 7-1) to the maximum extent practicable. Impacts associated with blocked fish access to the upper watershed and reduced base flows will not be completely addressed in the Bull Run but will be mitigated by the offsite measures in the Sandy Basin. Benefits provided by the Bull Run HCP measures are summarized in Table 8-2.
- **Effects in Sandy River Watersheds.** Substantial additional benefits for fall Chinook are provided by HCP measures in the lower Sandy River and its tributaries (e.g., Gordon Creek) and in the Middle Sandy River watershed. The lower Sandy has the primary spawning areas for fall Chinook in the Sandy River Basin; all anchor habitat reaches for fall Chinook are located in these areas. The primary limiting factors for fall Chinook for those areas include a lack of key habitat quantity and diversity, and reduced channel stability due to loss of large wood, increased channel confinement, and simplification of the stream channel. HCP measures H-4–H-9, H-11, H-12, and H-13 will improve these conditions and thereby contribute to improving fall Chinook productivity. Fall Chinook also can utilize the mainstem Sandy River upstream of the Bull Run. The mainstem Sandy River habitat upstream of the Bull Run is likely to improve with the removal of Marmot Dam in July 2007. Measures in the middle Sandy Basin also benefit fall Chinook by improving riparian zone conditions and increasing large wood levels. Benefits provided by the offsite measures are summarized in Tables 8-7 and 8-8 and in Appendix E, and Tables E-5 and E-6.
- **Timing for Implementing Measures.** The timing for implementing measures relevant to fall Chinook and other species is provided in Tables 7-6 through 7-12. Measures in the lower and middle Sandy River are primarily scheduled for HCP Years 6-10 based on specific input from NMFS staff to wait for the removal of Marmot Dam so that the post-removal conditions would be known and benefits of the HCP measures would not be compromised. The City will be conducting effectiveness monitoring for the instream measures; the objective in those cases is to accrue 80 percent of the predicted habitat change within 15 years of implementing each measure (see Chapter 9).
- **Population Response.** Although the HCP is not intended to guarantee specific population responses, implementation of the HCP is expected to result in improved population conditions for fall Chinook. Table 8-10 describes the anticipated increases of the four VSP parameters: abundance, productivity, diversity, and spatial structure. The estimated population response compared to the Modified Historical Bull Run Condition also indicates that implementation of the HCP will likely result in population responses greater than the production potential in the Bull Run watershed. Neither of these estimates includes the habitat or population benefits that will result from the $9 million Habitat Fund.
- **Accumulation of Habitat Benefits.** The HCP conservation measures will accumulate benefits for fall Chinook at varying rates. Figure 8-5, which is based on EDT model results, depicts the accumulation of benefits over the 50-year HCP term. The figure shows the

predicted increase in adult fall Chinook abundance that could result from the habitat changes. Benefits are organized according to three general categories of HCP measures: flow, instream actions, and riparian easements. Fish passage improvements for Cedar Creek are not anticipated to benefit fall Chinook. The City assumes that the benefits from large wood additions would only contribute to adult fall Chinook abundance for the first 15 years of their project life. This is a very conservative assumption because it is likely that the wood will be in the various stream reaches beyond 15 years and adding some habitat value for fish. Other instream actions, such as the opening of side channels and riprap removal, are considered permanent for the purpose of the HCP. Riparian easements are assumed to take 15 years before beginning to provide benefits, and they would not provide full benefits until 30 years after implementation. Flow measures will provide habitat for fall Chinook starting in Year 1 of the HCP.

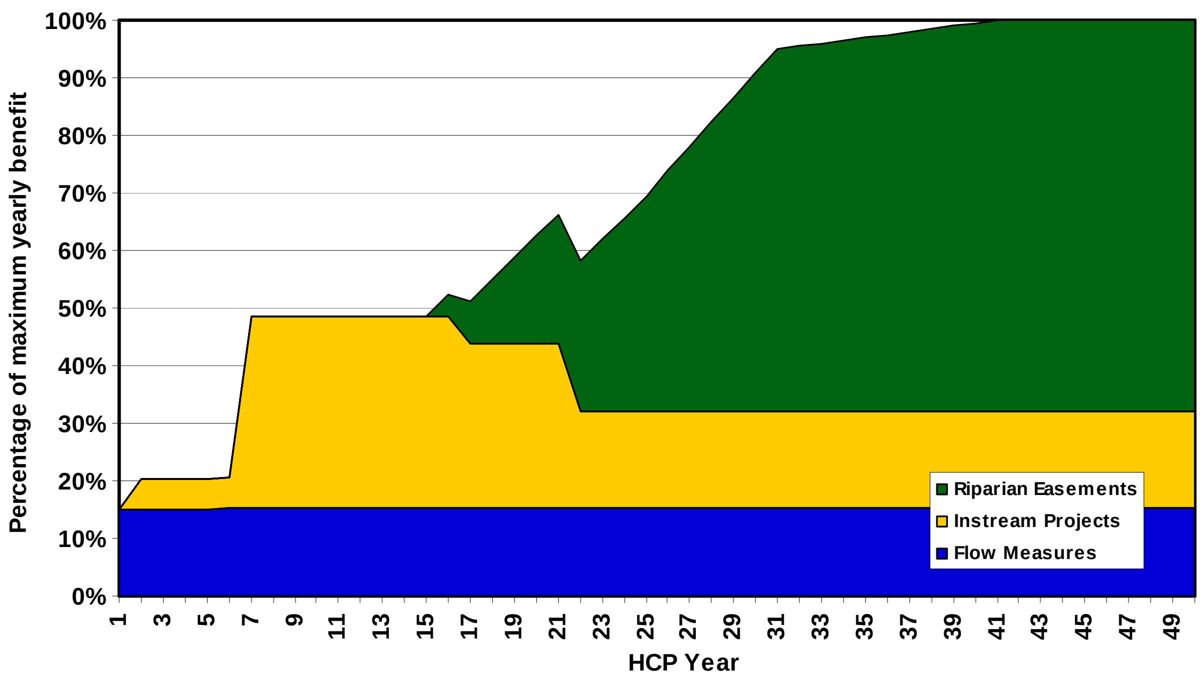


**Figure 8-5. Accumulation of Predicted Benefits to Fall Chinook from HCP Measures over Time[a]**

Source: EDT model runs, April 10, 2007.

[a]The accumulated benefits exclude benefits from the following measures: H-3—Little Sandy 1 and 2 LW Placement, P-2—Alder 1 Fish Passage, P-3—Alder 1A Fish Passage, H-25—Salmon 2 Carcass Placement, H-29—Zigzag 1A, 1B, and 1C Carcass Placement

The full fall Chinook benefits would be realized by approximately HCP Year 40. This maximum benefit level closely corresponds to the abundance number used in Table 8-11 for the “HCP Measures With Cedar Creek” scenario, but the benefit level excludes the benefits of large wood additions. Through the term of the HCP, the cumulative total benefits will be 21 percent from the flow measures, 28 percent from instream measures, and 51 percent from riparian easements.

**The City believes the HCP, as a whole, meets ESA Section 10 requirements for fall Chinook.**

### 8.2.2 Spring Chinook Habitat Effects

The HCP measures in the Bull Run watershed minimize the effects on juvenile and adult spring Chinook salmon in the lower Bull Run River to the maximum extent practicable. Offsite measures were selected to provide additional benefits for spring Chinook to help mitigate for the effects not avoided in the Bull Run. In addition, offsite measures that mitigate for impacts on other covered species also provide benefits for spring Chinook. Chapter 11 describes the City's commitment to fund the implementation of the necessary measures.

The potential effects of the City's Bull Run water supply operations on spring Chinook salmon are described in five subsections:

1. Effects in the lower Bull Run River—Describes the habitat effects of both the City's water supply operations and the HCP measures on lower Bull Run habitat for spring Chinook
2. Effects in the lower Sandy River—Describes the habitat effects of both the City's water supply operations and the HCP measures on habitat in the lower Sandy River for spring Chinook
3. Effects in the Columbia River— Describes the effects of using the City's groundwater supply at the Columbia South Shore Well Field on fish habitat in the Columbia River
4. Effects in Sandy River Basin watersheds—Describes the habitat effects of the offsite HCP measures on spring Chinook habitat in watersheds of the Sandy River Basin
5. Effects on the Sandy River populations, by VSP parameter—Describes the population effects of all of the HCP measures (those in the Bull Run and those in the Sandy River Basin offsite locations) on abundance, productivity, diversity, and spatial structure for spring Chinook
6. Comparison to a population benchmark—Compares estimates of spring Chinook abundance under historical conditions to estimated abundance after HCP implementation

Summaries for all subsections appear in gray shaded boxes. A detailed description of the effects for the species in the geographic location follows each summary. Conclusions about the habitat effects on spring Chinook from implementation of all HCP measures, including a discussion of the predicted accumulation of habitat benefits over time, are provided on page 8-77.

### Summary of Effects on Spring Chinook in the Bull Run Watershed from Bull Run Water Supply Operations and HCP Measures

The City identified 10 types of effects that the conservation measures will have on spring Chinook salmon in the Bull Run Watershed. The City also analyzed the potential impacts on the base flow of the Columbia River from the HCP flow commitments.

- Impacts associated with fish access to the upper Bull Run watershed, low base flows, and low weighted usable areas will be reduced with the Bull Run conservation measures, but not all impacts will be avoided. Those impacts that are unavoidable will be offset by the Sandy offsite conservation measures.
- The HCP will avoid impacts on spawning gravel, flow downramping, and riparian function in the lower Bull Run. There will be some short-term water temperature impacts, but in the long term, the natural thermal potential of the lower river will be returned by the City's infrastructure and operational changes for its dams and reservoirs.
- The removal of large wood at the reservoirs is considered a small impact on spring Chinook and the City's riparian zone protective measures will improve large wood levels in the future.
- The City does not know whether TDG levels harm spring Chinook in the lower Bull Run but the species will be monitored under this HCP and addressed through adaptive management provisions described in Chapter 9.
- The City's flow measures will have an extremely small effect on the Columbia River base flows and spring Chinook habitat will not be affected.

Table 8-12 summarizes the effects of the water supply operations, the reference condition for each effect, and the predicted effects from the City's HCP conservation measures.

Table 8-12. Effects of the Bull Run Measures on Lower Bull Run River Habitat for Spring Chinook[a]

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base flows | | |
| Winter/Spring Period (Juvenile Rearing) | Natural Bull Run base flows | HCP flows will be 77 to 81% of natural base flows during the juvenile rearing period. |
| Fall Period (Spawning) | | HCP flows will be 36 to 46% of natural base flows during the spawning period. |
| Weighted Usable Area (WUA) | | |
| Juvenile Rearing (Summer) | Natural flow Weighted Usable Area | HCP WUAs for juvenile rearing in the summer will be 60 to 100% of the maximum WUA value. |
| Juvenile Rearing (Winter) | | Projected HCP median flows will result in maximum WUA values for Chinook rearing from December through May. Impacts will be avoided. |
| Spawning | | HCP WUAs for spawning will be 2 to 67% of the natural flow WUA levels. |
| Flow Downramping | Protective downramping rate: 2"/hour | The City will meet the protective downramping rate (2"/hour) and fish stranding effects will be minimal. |
| Little Sandy River Base Flows | Natural flow; free-flowing | City's commitment to forgo development of the Little Sandy water rights will ensure free-flowing conditions for approximately 10 new miles of stream habitat in the Little Sandy River. |

Table 8-12. Effects of the Bull Run Measures on Lower Bull Run River Habitat for Spring Chinook[a], continued

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Water Temperature | ODEQ standard: natural thermal potential | There will be minor, short-term water temperature impacts prior to year 2012. By year 2012, the natural thermal potential of the lower Bull Run River will be met.<br>Water temperature impacts for winter and summer rearing will be avoided. Under natural thermal potential, water temperatures for spring Chinook spawning will be too warm. |
| Large Wood | Natural wood routing and accumulation | Removal of large wood from the reservoirs to protect the water supply infrastructure does not substantially affect large wood in the lower Bull Run River because the channel is a transport reach. |
| Spawning Gravel | Natural levels of gravel recruitment | The City will replace the natural level of gravel recruitment in the lower Bull Run River. All impacts will be avoided. |
| Fish Access | Historical fish anadromy<br>Total blocked stream miles in the Bull Run River watershed: 26.9<br>Blocked free-flowing miles in the Bull Run River watershed (excluding the Little Sandy River): 12.1 | City will not provide access into the upper Bull Run River.<br>Approximately 10 miles of river will be provided in the Little Sandy River, of which 8 miles could be used by spring Chinook. |
| Riparian Function | Mature riparian zones | City's lower Bull Run riparian lands are currently in good condition. Protective measures in the HCP will maintain and somewhat improve these conditions as younger trees mature. |
| Total Dissolved Gases (TDG) | ODEQ standard: maximum of 110% saturation at flows below the 7Q10 flow. | The City does not believe there are elevated TDG levels in the current range of anadromy at flows below the 7Q10 flow, but the City will continue monitoring to determine whether the ODEQ standard is being met. |

[a]For the list of conclusions about the habitat effects of all HCP measures on spring Chinook, see page 8-77.

### Habitat Effects in the Lower Bull Run River from Bull Run Measures

The effects on spring Chinook in the lower Bull Run River are described in the following categories: streamflow, water temperature, large wood, spawning gravel, access, and riparian function.

*Streamflow*

The City analyzed streamflow effects on spring Chinook by two means: comparing the effects of the HCP Bull Run base flows with the natural (pre-water-system) conditions; and determining the spring Chinook spawning and rearing WUA likely to result from Bull Run flow measures.

**Bull Run Base Flows.** The City compared an estimate of median monthly flows (50 percent exceedance flows) under natural conditions (i.e., no dams or diversions in the Bull Run watershed) with anticipated flows resulting from implementation of the HCP (assuming normal and critical years occur at the same frequency in the Bull Run as they have in the past). A 64-year hydrological record (1940–2004) was used for the analysis. The estimated median flows for the Bull Run River upstream of the Little Sandy River are shown in Figure 8-6; all flow amounts are relative to the USGS Gauge No. 14140000) located at RM 4.7 on the Bull Run River. The flow analysis considers spring Chinook utilization of habitat in the lower Bull Run River, as shown in the periodicity chart in Chapter 5 (Figure 5-18).

Table 8-13 lists the median natural flows and median flows anticipated from implementing the HCP. The comparison is for flows in two segments: upstream of the confluence with the Little Sandy River (RM 3.0—RM 5.8), and downstream of the Little Sandy River (RM 0–RM 3.0). For the portion of the Bull Run River downstream of the Little Sandy River, median flows were determined using the estimated Little Sandy median natural flows that would occur after the Little Sandy Dam is removed in 2008.

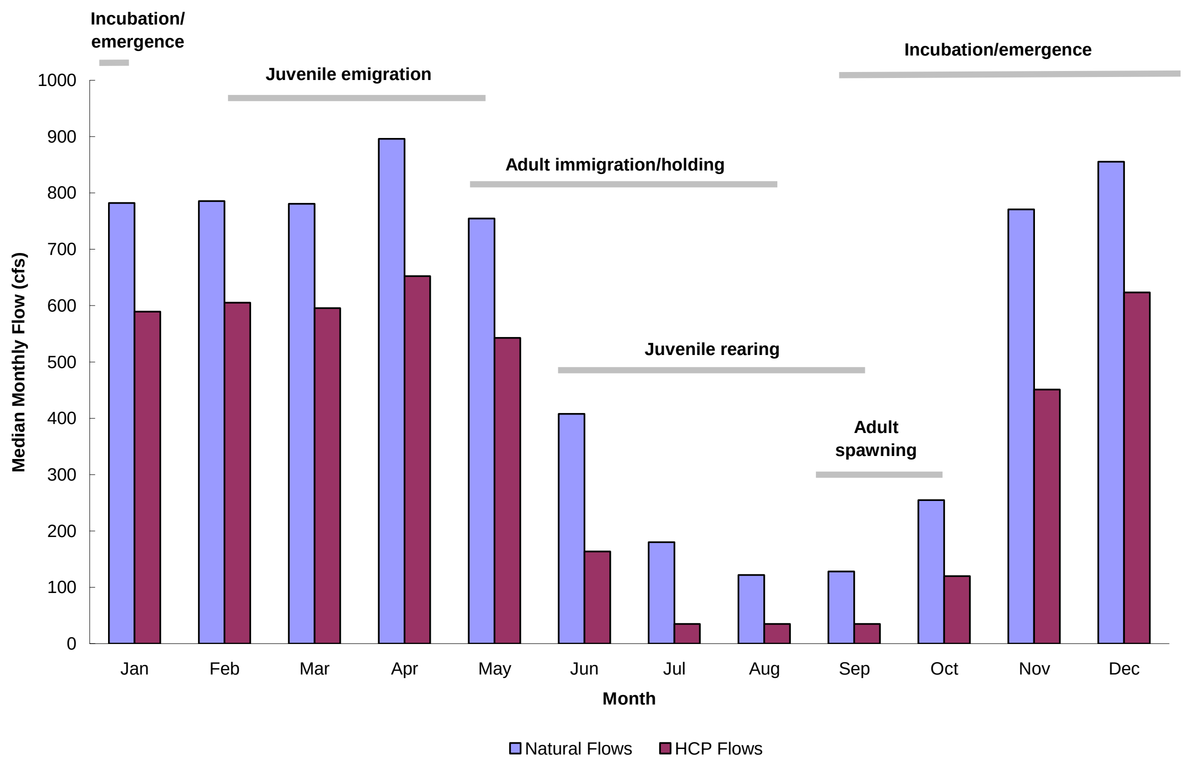


**Figure 8-6. Median Monthly Flows and Peak Periods of Occurrence for Spring Chinook Salmon in the Lower Bull Run River above the Little Sandy River Confluence[a]**

Source: Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000 (RM 4.7).

[a]Although peak juvenile rearing period is shown here, spring Chinook rearing occurs all year. See Figure 5-18 for periods of occurrence in the lower Bull Run River.

**Table 8-13. Natural and HCP Median Flows by Month for the Lower Bull Run River**

| | Flows above Little Sandy (cfs)[a] | | Flows below Little Sandy (cfs)[b] | |
|---|---|---|---|---|
| **Month** | **Natural** | **HCP** | **Natural** | **HCP** |
| **January** | 782 | 611 | 938 | 765 |
| **February** | 785 | 608 | 957 | 776 |
| **March** | 780 | 606 | 932 | 760 |
| **April** | 896 | 672 | 1,072 | 846 |
| **May** | 755 | 563 | 898 | 709 |
| **June** | 408 | 196 | 487 | 274 |
| **July** | 180 | 35 | 213 | 67 |
| **August** | 122 | 35 | 141 | 54 |
| **September** | 128 | 35 | 152 | 55 |
| **October** | 255 | 120 | 304 | 166 |
| **November** | 771 | 427 | 924 | 608 |
| **December** | 857 | 654 | 1,031 | 829 |

[a]Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS No. Gauge 14140000, Bull Run River (RM 4.7).

[b]The sum of median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7) and median monthly flows taken at USGS Gauge No. 14141500, Little Sandy River (RM 1.95).

For September and October, the median HCP flow for the Bull Run River above the confluence with the Little Sandy River will be approximately 59 percent lower than the natural flow. For the Bull Run downstream of the Little Sandy River, the HCP flows will be approximately 51 percent lower than the natural flow levels.

June through September is the early summer transition and summer/early-fall periods for juvenile and holding adult spring Chinook. For the Bull Run River upstream of the Little Sandy River, the HCP flow is 64 percent lower than the natural median flow under the City's proposal. For the Bull Run downstream of the Little Sandy, the HCP median flow is 54 percent lower than the median natural flow.

Juvenile emigration occurs primarily in April and May before the flows decrease. For the Bull Run River downstream of the Little Sandy River, the median HCP flows will be 20 percent lower than the projected natural flows for January through May. Upstream of the Little Sandy River confluence, the median HCP flows will be approximately 23 percent lower than the projected median natural flows for that time period.

Although the HCP includes a provision to reduce flows in the fall during critically dry years, the frequency of these reductions will be limited by the City's commitment. Critical fall flows will only occur in 10 percent of the HCP years. The City's commitment will also limit the occurrence of critical fall flows to no more than two consecutive years. If critical fall flows are triggered, the City will not release critical fall flows in a specific year when most adult fish would return to their place of origin. When a critical fall flow year occurs, the City will not implement critical fall flows four years later regardless of whether the critical fall trigger occurs (see Measure F-2 in Chapter 7).

**Effects of Base Flows on Spring Chinook Spawning.** The primary spawning time for spring Chinook in the Bull Run River is from early September to mid-October (Beak 2000a, Clearwater BioStudies 2005). The City's flow measures will not significantly improve spawning conditions for spring Chinook because the lower Bull Run will still have reduced base flows and the primary limiting factor is warm water temperatures. The significance of the difference between natural and HCP flows for spring Chinook spawning activity is further described in the discussion titled Bull Run Weighted Usable Area (WUA), below. The water temperature impacts are discussed in the Water Temperature section below.

**Effects of Base Flows on Spring Chinook Rearing.** Juvenile spring Chinook rearing distribution is not well documented in the Sandy River Basin (ODFW 2001). Some studies suggest that spring Chinook fry emerge in mid- to late winter and begin to drift downstream, probably to rear in larger mainstem areas of the watershed. During snorkeling efforts in the lower Bull Run River from the last decade, few juvenile spring Chinook were ever observed.

The City's HCP flows are consistently highest during the winter and spring period, which will have a low effect on spring Chinook during that time. The HCP median flows for January through May would average approximately 610 and 770 cfs for the Bull Run River upstream and downstream, respectively, of the Little Sandy River. These relatively high flows will maintain ample water depths to protect egg incubation in and fry emergence from redds constructed during the preceding fall spawning period.

Adult spring Chinook migrate into the Bull Run River in late spring and early summer and have been observed as early as July (Beak 2000a). It is difficult to estimate the magnitude of the effects of flow on adult immigration because adult spring Chinook hold in large pools. The physical character of these large pools does not change much with changes in flow; therefore, the City concludes that adult holding habitat availability is not affected by different flow levels. The differences between natural flow and HCP flow levels for rearing spring Chinook are explained in the WUA discussion below.

It is suspected that warm water temperatures might be the primary limiting factor for spring Chinook; those effects are discussed in the Water Temperature section.

**Bull Run Weighted Usable Area.** WUA values were calculated from median flows for spring Chinook spawning and rearing to assess the effect of the HCP flow measures on the lower Bull Run River habitat. WUA estimates for natural flow conditions (i.e., no dams and no diversions) and for the HCP flows, both upstream and downstream of the Little Sandy River, are provided in Table 8-14.

R2 Resource Consultants (1998) estimated the flow-habitat relationships for spring Chinook spawning and juvenile rearing in the Bull Run River using the PHABSIM model. As described in Section 8.2.1, they generated estimates of WUA for up to 500 cfs in four segments of the Bull Run River. The four segments were combined into the two segments of the lower Bull Run River:  upstream and downstream of the Little Sandy River. For flows greater than 500 cfs, goodness-of-fit curves were used to extrapolate WUA values. The WUA estimates for natural and HCP flows are compared using a "percentage of natural" metric. For example, if the HCP percentage of natural flow is 90 percent, the HCP median flow will yield a WUA value of 0.9 acre in a month, and the WUA value would be 1.0 acre in a month.

**Extrapolation above 500 cfs.** Extrapolation is considered to provide conservative WUA estimates (Carlson, pers. comm., 2005), although some uncertainty exists regarding extrapolation of Chinook spawning WUA values above 500 cfs. That is, the goodness-of-fit curves used to extrapolate WUA values for Chinook spawning continue to trend upward as flows increase above 500 cfs. However, WUA values for Chinook spawning may start to decline at higher flow levels, such as those observed by R2 Resource Consultants (1998) in the segment of the Bull Run River below the Bull Run powerhouse (i.e., segment 1). In this segment, PHABSIM modeling to 2,400 cfs was possible, and the modeled WUA values for Chinook spawning start to decline at flow levels above about 700 cfs (R2 Resource Consultants 1998).

**Estimated WUA for Spawning.** The City's HCP flows will create a total spring Chinook spawning WUA that is 2 percent to 67 percent of the corresponding natural flow WUA (see Table 8-14). The City's flow WUA levels are lowest in September for the section of the Bull Run River upstream of the Little Sandy River and highest in October for the section downstream of the Little Sandy River.

**Table 8-14. Comparison of Chinook Spawning Weighted Usable Area (WUA) Values in the Bull Run River**

| Month | Natural Flow (cfs) | Natural Flow WUA (acres) | HCP Flow (cfs) | HCP Flow WUA (acres) | Percentage of Natural Flow WUA |
|---|---|---|---|---|---|
| *Above the Little Sandy River (Upper Section)* | | | | | |
| September | 128 | 0.60 | 35 | 0.01 | 2 |
| October | 255 | 1.05 | 120 | 0.52 | 50 |
| November | 771 | 2.07 | 427 | 1.39 | 67 |
| December | 857 | 2.24 | 654 | 1.83 | 82 |
| *Below the Little Sandy River (Lower Section)* | | | | | |
| September | 152 | 0.79 | 55 | 0.39 | 49 |
| October | 304 | 1.19 | 166 | 0.82 | 67 |
| November | 924 | 1.41 | 608 | 1.40 | 99 |
| December | 1,031 | 1.41 | 829 | 1.41 | 100 |

Source: R2 Resource Consultants 1998a

The HCP includes a provision to reduce flows in the fall during water years with critical seasons (see Measure F-2 in Chapter 7). The frequency of these reductions will be limited by the City's commitment. Critical fall flows will only occur in 10 percent of the HCP years. The City's commitment will also limit the occurrence of critical fall flows to no more than two consecutive years. If critical fall flows are triggered, the City will not release critical fall flows in a specific year when most of the resulting adult fish would return to their place of origin. When a critical fall flow year occurs, the City will not implement critical fall flows four years later regardless of whether the critical fall trigger occurs. This will reduce impacts on spawning spring Chinook because normal fall flows will be provided when the majority of adults from a specific cohort return.

Even though the City's HCP flows will reduce WUA levels, high water temperatures are a more serious factor limiting spring Chinook spawning in the Bull Run. High water temperatures are caused by the reduced base flow levels and the release water temperature caused by Bull Run Dam 2, as discussed below.

**Estimated WUA for Rearing.** Spring Chinook juveniles rear from June through August. R2 Resource Consultants (1998) found that the estimated total habitat area (WUA value) for juvenile spring Chinook salmon increases at a rapid rate between zero and 100 cfs, with the most rapid increase occurring between 0 and 20 cfs (see Figure 5-12). The guaranteed minimum HCP flow in the summer is 20 cfs, although flows can vary from 20–40 cfs. The City's HCP flows will create WUA for spring Chinook rearing that will be approximately 60 to 100 percent of the WUA created by natural flows, as indicated in Table 8-15. Therefore, the City's HCP flows will have a beneficial effect on the summer rearing habitat for juvenile spring Chinook compared with current conditions, and limited effects compared with natural conditions.

**Table 8-15. Comparison of Weighted Usable Area (WUA) Values for Spring Chinook Juvenile Rearing in the Bull Run River**

| Month | Natural Flow (cfs) | HCP Flow (cfs) | Natural Flow WUA | HCP Flow WUA | Percentage of Natural Flow WUA |
|---|---|---|---|---|---|
| *Above the Little Sandy River (Upper Section)* | | | | | |
| **June** | 408 | 196 | 16.83 | 14.77 | 88 |
| **July** | 180 | 35 | 14.55 | 9.11 | 63 |
| **August** | 122 | 35 | 13.61 | 9.11 | 67 |
| **September** | 128 | 35 | 13.72 | 9.11 | 66 |
| *Below the Little Sandy River (Lower Section)* | | | | | |
| **June** | 487 | 274 | 12.23 | 13.58 | >100 |
| **July** | 213 | 67 | 13.60 | 11.16 | 82 |
| **August** | 141 | 54 | 13.09 | 10.46 | 80 |
| **September** | 152 | 55 | 13.24 | 13.24 | 100 |

Source: R2 Resource Consultants

Spring Chinook fry typically emerge in middle to late winter, then migrate downstream to a large mainstem area for rearing. R2 Resource Consultants (1998) estimated that the total habitat area (WUA value) for juvenile Chinook reaches its maximum at approximately 350 cfs downstream of the Headworks (RM 6.3) to the PGE Powerhouse (RM 1.5). For the river downstream of the powerhouse, the total habitat area (WUA value) for juvenile Chinook reaches its maximum at approximately 110 cfs; the amount of habitat area then stays constant with increasing streamflow.

The HCP guaranteed minimum flow for December through June is 120 cfs; the projected median flow would be approximately 200 to 850 cfs (see Tables 7-1 and 8 13 respectively). The HCP flows will create a total WUA for spring Chinook rearing that is approximately 90 percent of the WUA created by natural flows in the lower Bull Run, depending on the month during this period (Table 8-15). Therefore, the City's HCP flows would minimize any impacts to rearing juvenile spring Chinook in the lower Bull Run during the winter and spring time periods.

**Bull Run Peak Flows.** The City assessed effects on peak flows in the lower Bull Run River by evaluating the annual peak winter flows since Water Year 1960. This data set was used for the peak flow analysis because the USGS gauge was in another location prior to 1960. The City estimated peak winter flows in the absence of the City's water supply diversions, peak winter flows with current (2006) water diversions, and peak winter flows with estimated 2025 water diversions based on Metro's population projections. The estimated change in annual total water yield diverted for supply is expected to increase from 20 percent currently to 22 percent in 2025.

The estimated magnitude of the annual peaks with no water diversions ranged from 4,010 to 25,420 cfs, depending on weather conditions. The estimated magnitude of the annual peaks for current water demands ranged from 3,880 to 25,100 cfs. The estimated magnitude of the annual peaks for 2025 water demands ranged from 3,863 to 25,094 cfs. Differences were determined by comparing flows on individual peak flow dates. The differences between no diversions and current diversions ranged from 0.3 percent to 3.3 percent. The differences between no diversions and estimated 2025 diversions ranged from 0.6 percent to 3.7 percent.

The City also characterized each peak flow event into a return frequency category (i.e., less than 2-year event, 2-5 year event, 5-10 year event, 10-25 year event, 25-50 year event, and 50-100 year event). The flow conditions experienced in those events were applied to current water diversions and 2025 estimated water diversions. In only one case did the increase in winter season water diversions in 2025 cause a change in the return frequency category for peak events. The January 5, 1969 weather year changed from a slightly greater than 2-year event to a slightly less than 2-year event.

The City concluded from this analysis that implementation of the HCP will not significantly change the magnitude of peak flow events in the lower Bull Run River. Peak flow events will continue to occur with a frequency and magnitude similar to current conditions and similar to conditions that would occur without water supply diversions.

**Bull Run Scour Flows.** The HCP flow regime will reduce the risk of scour in spring Chinook redds in the lower Bull Run River, compared with historical flows. Based on a recent analysis (Carlson 2005), flow sufficient to mobilize gravels will occur less frequently and

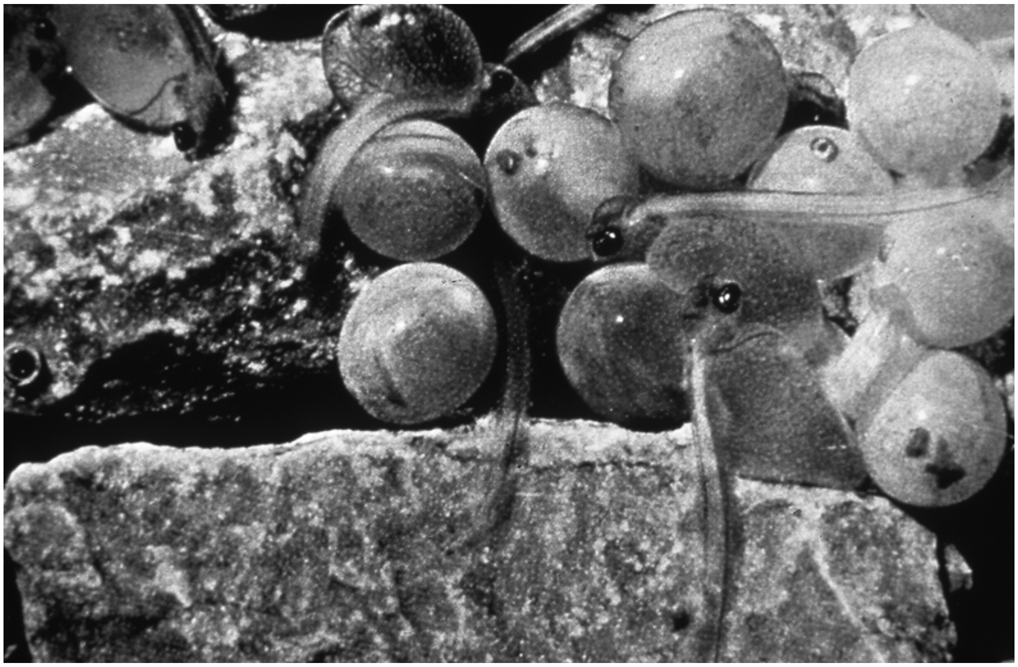

Photo courtesy of Bonneville Power Administration.

over fewer days during the HCP flows than during natural flows. The analysis focused on two time periods: primary egg incubation period for spring Chinook in the lower Bull Run from mid-October through December and fry emergence from January through mid-May, even though most of the spring Chinook will have emerged in the Bull Run from January through February.

A 25-year record (1980-2004) of mean daily flows in the lower Bull Run River was examined to determine the number of separate flow events large enough to mobilize spawning gravel. Those flows were contrasted with the flow regime estimated to occur under natural conditions (without City infrastructure and operations). Flows sufficient to mobilize gravels are expected to occur less frequently under the HCP flows than under natural flows. In addition, the rates of change during these peak events are likely to be lower under the HCP flows. This finding suggests that the HCP flow regime will reduce the risk of redd scour caused by peak flows compared with what would occur under natural conditions.

Even though the HCP flow measures are not anticipated to increase spring Chinook redd scour in the lower Bull Run River, the City will complete a redd scour study (see Chapter 9, Monitoring and Adaptive Management).

**Bull Run Flow Downramping.** The City's hydroelectric plant at the base of Dam 2 varies the streamflow in the lower Bull Run River during the winter and spring months when there is enough streamflow to run the facility. The current FERC license allows for a 2'/hour downramping rate for the lower Bull Run River, but the City is committing to a lower rate to protect juvenile salmonids.

The City studied juvenile salmonid stranding during different downramping events in the lower Bull Run River (Beak Consultants 1999; CH2M HILL 2002). The sites selected for monitoring included the widest areas of the channel considered most sensitive to ramping effects and potential stranding. Steelhead fry (about 40 mm average length) and yearling

(Age-1) juveniles were observed during the studies. No other salmonids were present during the stranding studies, and it is assumed that the behavior of juvenile steelhead is adequate for determining potential ramping rates effects. A ramping rate of no more than 2"/hour was recommended for the lower Bull Run River to protect salmonid fish. This rate is consistent with recommendations from the state of Oregon and others to protect against juvenile fish stranding (CH2M HILL 2002; Hunter 1992).

The City will minimize the risk of stranding juvenile spring Chinook by maintaining a maximum downramping rate of 2"/hour year-round for the hydroelectric powerhouse downstream of Bull Run Dam 2. All effects from flow downramping, however, cannot be avoided due to circumstances beyond the control of the City.

The City conducted a year-long evaluation of outages (Galida 2005) and determined that circumstances when the City would not meet the ramping rate occurred 0.4 percent of the time, which will have minimal effects on spring Chinook. These circumstances include natural storm flows, mechanical/control system failures that are impossible to predict, and FERC mandatory testing of project safety equipment. Out of the test period of approximately 8,800 hours of hydropower operations, the 2"/hour downramping rate was exceeded only for 35 hours. The exceedances occurred from mid-November through late-March and streamflow in the lower Bull Run River was 200-12,600 cfs. Natural stream flows were quite variable and since the reservoirs were full, the downramping rate could not be controlled by the City for approximately one-third of the 35 hours. Other exceedances can be attributed to equipment testing and operator error. Overall, the City was very successful in controlling the downward fluctuation of the lower Bull Run River.

The City's commitment to a downramping rate of 2"/hour will result in minimal effects on spring Chinook. The occurrences of downramping greater than 2"/hour will rarely occur in the future, and if they do, they will happen during the winter months. This is after the spring Chinook have spawned. The redds will not be negatively affected because the streamflows will be high enough to protect them. Also, there will be a very low potential for stranding juvenile spring Chinook because the higher downramps would occur only infrequently and sporadically during the late winter and early spring.

The City will continue to monitor downramping in the lower Bull Run as part of the compliance monitoring efforts (see Chapter 9).

**Little Sandy River Base Flows.** Forgoing development of the City's water rights on the Little Sandy River during the term of the HCP will help assure unimpeded natural flows on the Little Sandy River for spring Chinook. While the City acknowledges that the Little Sandy River probably did not historically produce a large number of spring Chinook due to its moderately confined channel width and dominance of the streambed by large cobbles, spring Chinook will have access to approximately 10 river miles of the Little Sandy River for spawning and rearing with this HCP.

***Water Temperature***

Spring Chinook salmon probably utilize the Bull Run River year-round, including the time periods with warm water temperatures such as the summer for juvenile rearing and the fall for spawning (see Figure 5-18 for the periodicity chart and Figure 8-7 for daily maximum temperatures).

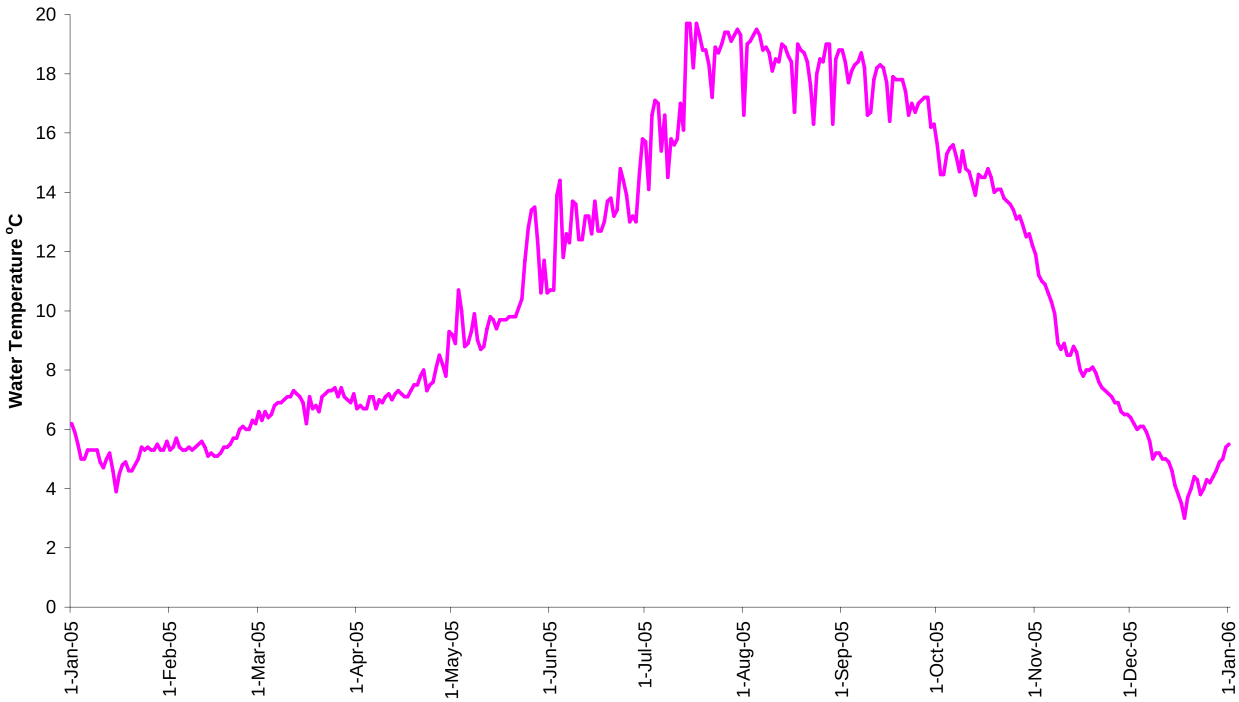


**Figure 8-7. 2005 Daily Maximum Water Temperatures for the Lower Bull Run River as Measured at USGS Gauge No. 14140000 (RM 4.7)**

Source: USGS Gauge No.14140000 on the Bull Run River (RM 4.7).

The reference condition for water temperature is the natural thermal potential of the lower Bull Run River. Natural thermal potential is defined by ODEQ in the Sandy River TMDL (ODEQ 2005) as the water temperatures that would occur in the Bull Run River if there were no dams or diversion. The City, in conjunction with ODEQ, has developed a method to establish the natural thermal potential of the lower Bull Run River and found that the current temperature regime of the Little Sandy River is a good surrogate for the Bull Run. (See temperature measure T-2 in Chapter 7 for more details.)

**Pre-Infrastructure Water Temperature Effects.** The City plans to make significant infrastructure improvements at Dam 2 to meet the natural thermal potential of the lower Bull Run River. However, prior to completion of the infrastructure improvements, water temperatures in the lower Bull Run River during the summer and September–October will exceed those preferred for rearing and spawning Chinook, as indicated in Figure 8-8.

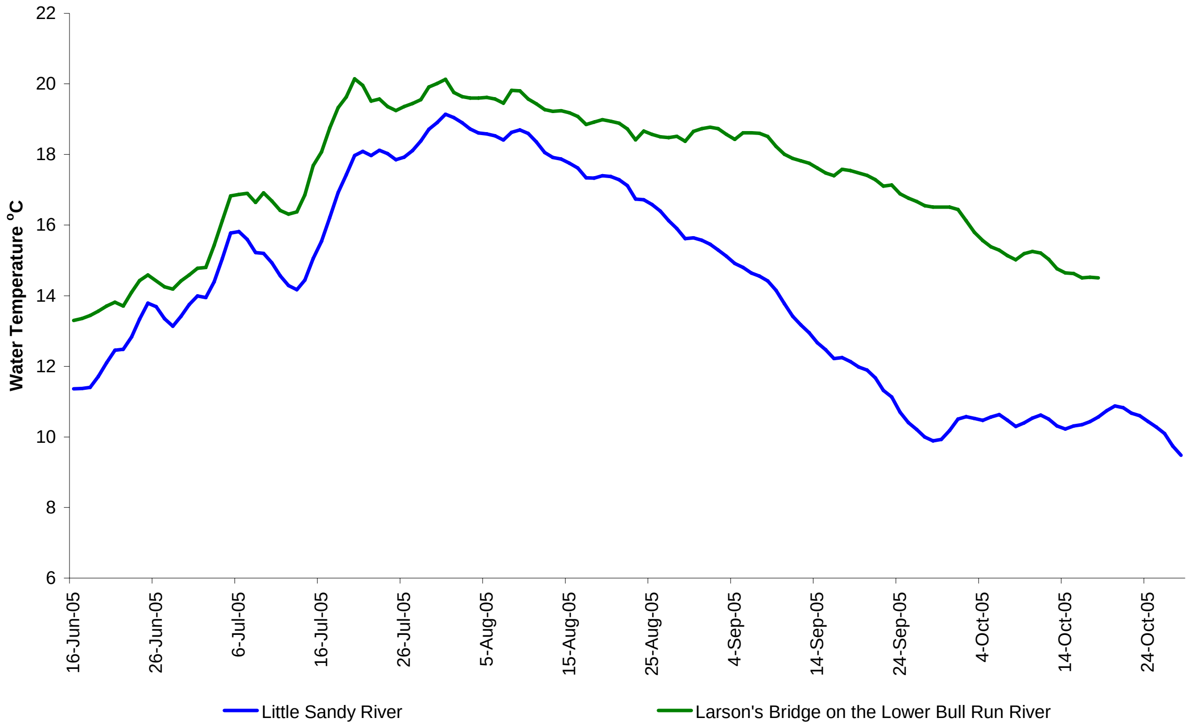


**Figure 8-8. Seven-Day Maximum Average Water Temperatures for the Little Sandy and Lower Bull Run Rivers, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and USGS Gauge No. 14140000 on the Bull Run River (RM 4.7).

The City will continue to carefully manage the amount of cool water in the reservoirs for downstream flow releases. Figure 8-8 indicates the water temperature performance that the City will be able to achieve in the first years of the HCP. For rearing spring Chinook in the summer and early fall, the City has established the interim goal of not exceeding 21 °C at Larson's Bridge on the lower Bull Run River. That target is cool enough to allow continued growth of spring Chinook. Although this temperature target is higher than the range preferred by rearing spring Chinook, it is the best performance outcome that the City can achieve with the current dam infrastructure. There will be some temporary effects on spring Chinook juveniles.

The City cannot provide favorable water temperatures during the prime spring Chinook spawning months of September and October. There is not enough cool water in the reservoir to meet the interim water temperature target of 21 °C for rearing spring Chinook and lower the water temperature in the fall for spawning. The water temperature of the lower Bull Run River, expressed at Larson's Bridge in Figure 8-8, would be approximately 16 °C—18 °C for the first two weeks of October, higher than ODEQ's water temperature criterion of 13 °C for spawning salmonids. The City has identified other offsite habitat compensation measures to mitigate for the impacts on spring Chinook salmon spawning in the lower Bull Run watershed.

**Post-Infrastructure Water Temperature Effects.** The City will complete infrastructure changes at the Dam 2 towers and the stilling basin and commit to daily operational flow management (Measure T-2). The City used the CE-QUAL-W2 water quality model to predict natural condition stream temperatures in the lower Bull Run River (City of Portland 2004). The model predicted that maximum stream temperatures would occur at Larson's Bridge (RM 3.8) in the lower Bull Run River. City staff and ODEQ staff evaluated modeling results and empirical data and concluded that natural stream temperatures in the lower Bull Run River could be estimated using the stream temperature of the Little Sandy River (see Figure 8-9).

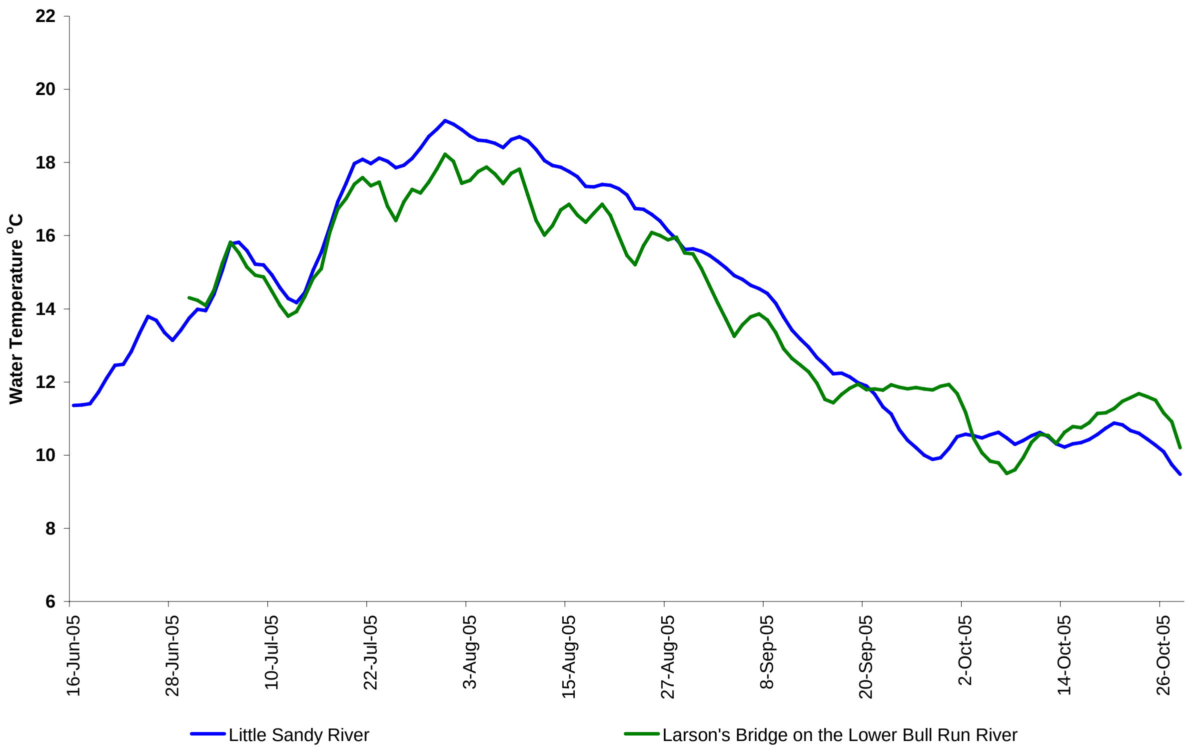


**Figure 8-9. Comparison of Actual 7-Day Maximum Water Temperatures for the Little Sandy Compared with Predicted 7-Day Maximum Average Temperatures for the Lower Bull Run River, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and CE-QUAL-W2 Modeled Temperatures (February 2006).

The summer and early fall water temperatures in 2005 shows that water temperatures at Larson's Bridge will be generally lower than temperatures in the Little Sandy but are within approximately 1 °C (see Figure 8-9). ODEQ has established water temperature criteria for the Larson's Bridge location under the authority of the Clean Water Act and the Sandy Basin TMDL (see Measure T-2 in Chapter 7).

Within five years of the start of the HCP, the infrastructure changes at Dam 2 will be completed and the natural thermal potential of the Bull Run River will be met.  Water temperature impacts on spring Chinook would be minimized.

**Diurnal Water Temperature Fluctuations.** The City anticipates that the diurnal water temperature fluctuations in the lower Bull Run River will be less than what has been observed in recent years. The fluctuations likely to result from implementing the HCP measures were estimated using modeling and measured water temperatures from the lower Bull Run and Little Sandy rivers. Table 8-16 lists observed and expected temperature fluctuations for the summer and late summer months. These are the months when the City's operations will affect the diurnal temperature fluctuations due to the water temperature compliance measures described in this HCP. During other months of the year, the diurnal water temperatures fluctuations should not be affected. The fluctuations expected after implementing the HCP measures are predicted to be smaller than the fluctuations that would occur under natural conditions.

**Table 8-16. Diurnal Water Temperature Fluctuations (°C)**

| Month | Bull Run Observed (current conditions) | Little Sandy Observed (natural conditions) | Expected HCP |
|---|---|---|---|
| June | 4–6 | 0.5–5 | 2–3 |
| July | 4–6 | 1–5 | 2–3 |
| August | 3–5 | 1–5 | 2–3 |
| September | 2–3 | 1–4 | 1–2 |

Source: Bull Run observed temperatures: USGS Gauge No. 14140000 on the Bull Run River (RM 4.7); Little Sandy observed temperatures: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8); expected HCP temperatures: CE-QUAL-W2 Modeled Temperatures (February 2006).

The City reviewed available research that describes the influence of fluctuating water temperature on the growth of salmonids. Most of the studies focused on rainbow, steelhead, coho, and sockeye salmon. Experiments on steelhead and coho (Hahn 1977; Grabowski 1973; and Thomas et al. 1986) indicated that fluctuating water temperature tests and the constant temperature test exposures produced essentially equivalent results. The City concludes that these reductions in diurnal water temperature fluctuations will not affect spring Chinook or other salmonids that utilize the lower Bull Run River.

### *Large Wood*

Large wood is removed from the upper end of Reservoir 1 to protect the downstream water supply dams from damage. USFS owns this wood because it is transported by tributaries from national forest land. Because this wood is not allowed to travel down the lower Bull Run River, a small amount of beneficial habitat is potentially lost for spring Chinook. The lower Bull Run River is, however, a high-order steep stream and is not likely to trap and store large wood. Photographs taken of the lower Bull Run in the late 1890s, before the dams and water diversions were constructed, show little large wood in the channel. The lower river is probably a transport reach for large wood.

The channel of the river is dominated by bedrock and boulders. This channel roughness supports diverse habitats, including about 27 percent pool habitat. The presence of this pool habitat suggests that large wood is not important for pool formation and that the addition of large wood would provide only a minor increase in pool habitat.

The City does not plan to artificially place large wood in the lower Bull Run River above Larson's Bridge because of concerns about the vulnerability of the water supply infrastructure (such as conduit trestles). The City will let natural recruitment of large wood occur in the lower Bull Run River downstream of Larson's Bridge. Trees that fall naturally will be left in place to modify the stream channel. This large wood could slightly improve habitat conditions for spring Chinook by creating pools in localized areas and trapping finer gravels in the lower 3.8 miles of the lower Bull Run River.

***Spawning Gravel***

Two Bull Run dams interrupt bedload and gravel movement to the lower Bull Run River, resulting in reduced spawning habitat for spring Chinook salmon and other species. The estimated historic gravel supply rate was roughly 30 to 1,000 cubic yards (CH2M HILL 2003b). The City will place approximately 1,200 cubic yards per year for the first five years and 600 cubic yards per year thereafter (see Measure H-1 in Chapter 7). The gravel replacement rate will be higher than the estimated natural accumulation. Placement of gravel in the lower Bull Run River under the HCP will significantly improve the spawning conditions for spring Chinook. The City will monitor the effects of the gravel placement to determine whether the measure should continue for the term of the HCP, or should be modified (see Section 9.4, Adaptive Management Program in Chapter 9).

***Access***

Spring Chinook were first blocked from the upper Bull Run watershed in 1921 by construction of the Diversion Dam (approximately RM 5.9). The dam was constructed to divert Bun Run water into water conduits to serve the greater Portland metropolitan area. In 1964, as part of the Dam 2 construction, a rock weir at RM 5.8 was built to create the Dam 2 plunge pool for energy dissipation. That structure is now the upstream limit for spring Chinook in the Bull Run watershed.

Spring Chinook access will remain blocked by the rock weir at RM 5.8 during the term of the HCP, preventing access to approximately 21.3 miles of the upper Bull Run River historically used by this species. Of these blocked miles, only 12.1 miles are free-flowing river; 9.2 miles are inundated by City reservoirs.

When PGE removes the Little Sandy Dam, spring Chinook will have access to an additional 5.6 miles of the mainstem Little Sandy River, and possibly 2.0 additional miles of tributary streams.[7] The City's agreement to maintain flows for fish in the Little Sandy (see Measure F-4, Chapter 7) will help retain habitat benefits from this renewed access to the historical habitat for spring Chinook.

[7] See Section 4.1.5 Water Quantity and Water Rights in Chapter 4 for more information on the Little Sandy Dam removal.

Photo courtesy of Char Corkran.

***Riparian Function***

The City owns land along 5.3 miles of the lower Bull Run River (1,650 acres). The City's land represents 82 percent of the riparian corridor below Dam 2. Managing these lands to protect riparian habitat (see Measure H-2 in Chapter 7) will slightly improve habitat for spring Chinook. Approximately 30 percent of the riparian corridor along the lower river is late-successional (late-seral) timber than can provide immediate large wood recruitment to the channel. In addition, 80 percent of the riparian corridor is of mid- to late-seral age that will provide wood to the channel at an increasing rate over the next 10 to 70 years (Cramer et al. 1997). The large trees that fall into the lower Bull Run will affect localized stream gradient, sort gravels, and create small pools that will be beneficial to spring Chinook. In the long-term, large wood will also route downstream to the mainstem Sandy River where it will create habitat for Chinook.

Analysis of shading in the lower Bull Run River indicates that riparian vegetation currently intercepts 40 to 60 percent of the total solar radiation that potentially could reach the water surface (Leighton 2002). This shading provides a substantial benefit by maintaining lower water temperatures. This shading benefit will become greater over time as the vegetation continues to mature. The mature vegetation in the lower Bull Run combined with the temperature measures (infrastructure changes to the intake towers and temperature management) will closely approximate natural water temperatures and reduce the effects of water system operations on spring Chinook.

### *Total Dissolved Gases*

Oregon's Water Quality Standards state that TDG levels should not exceed 110 percent of saturation unless flows exceed the ten-year, seven day average flood (7Q10) flow for the site [OAR 340-041-0031]. The 7Q10 flow for the lower Bull Run River is 5,743 cfs. The City has monitored all water system structures, valves, or turbines that could elevate TDG levels since 2005, and has determined that spring Chinook are unlikely to be adversely affected by TDG levels in the Bull Run River. A 55-foot deep stilling pool at the base of the Dam 2 spillway is the site most likely to produce TDG levels that could affect spring Chinook. This location, however, is upstream of the range of anadromous fish. Monitoring by the City indicates that elevated levels of TDG quickly decrease as water passes over the rock weir below the stilling pool (RM 5.8). The City has never measured TDG levels that met or exceeded 110% in the anadromous portion of the Bull Run River, unless the 7Q10 flow was also exceeded. TDG levels further dissipate between the rock weir and Larson's Bridge, about 1 mile downstream (RM 4.7). Almost all of the spring Chinook observed in the lower Bull Run River were downstream of Larson's Bridge (Strobel 2007a, Clearwater BioStudies 1997; 2006; ODFW 1998; Beak Consultants 2000a,b). Spring Chinook are probably not impacted by TDG levels in the Bull Run River. The City, however, will continue to monitor TDG levels in the Bull Run as described in Chapter 9 and Appendix F, Monitoring Plans and Protocols.

**Summary of Effects in the Lower Sandy River from Bull Run Water Supply Operations and HCP Measures**

The City identified five types of effects that water supply operations could have on spring Chinook habitat in the lower Sandy River.

- Base flows in the lower Sandy would be reduced by continued water supply operations in the Bull Run but the weighted usable area for spring Chinook spawning and juvenile rearing habitat will be increased with the City's HCP flow measures.
- Flow downramping effects in the lower Sandy will be avoided because of the City's downramping commitments in the Bull Run.
- The City's HCP measures will probably have small beneficial effects on water temperatures in the lower Sandy.
- The City will also minimize the impact of removing large wood from the lower Bull Run by adding large wood directly into the lower Sandy.

Overall, the City's HCP measures will have positive effects on the habitat in the lower Sandy River. Table 8-17 summarizes the habitat effects of the Bull Run measures in the lower Sandy.

**Table 8-17. Effects of the Bull Run Measures on Lower Sandy River Habitat for Spring Chinook[a]**

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base Flows | Natural Sandy River base flows | Flows after implementation of the HCP will be more than 80% of natural base flows.[b] |
| Weighted Usable Area (WUA) | Natural Sandy River base flows | Flows will increase WUA spawning habitat by up to 20 percent.[c] Lower Sandy River flows will have higher WUA values for rearing Chinook juveniles. |
| Flow Downramping | Protective downramping rate: 2"/hour | The City's water supply operations will have minimal effects on fish stranding due to downramping. |
| Water Temperature | ODEQ standard: natural thermal potential | The City's HCP measures will probably have small water temperature benefits. |
| Large Wood | Natural wood accumulation | Removal of large wood from the reservoirs reduces the amount of large wood loading to downstream Sandy River reaches and reduces channel complexity.<br>City measures will increase large wood levels and habitat diversity, minimizing adverse effects of Bull Run operations in the Sandy River below the Bull Run confluence. |

[a]For the list of conclusions about the habitat effects of all HCP measures on spring Chinook, see page 8-77.

[b]Based on flow data from 1985-2001, natural base flows were reduced by 4-19 percent (CH2M HILL 2002) .

[c]Based on flow data from 1985-2001, habitat for spawning was increased by 2-18 percent.

## Habitat Effects in the Lower Sandy River from Bull Run Measures

The EDT database and model were used to identify limiting factors having the greatest effect on spring Chinook in the lower Sandy River below the confluence of the Bull Run River. The factors identified were food, habitat diversity, harvest, flow, channel stability, competition from the same species, predation, water temperature, pathogens, and sediment. Of these 10 factors, three are potentially affected by water supply operations in the Bull Run: flow, water temperature, and large wood recruitment (as a subfactor of habitat diversity). The other seven factors are not directly related to water supply operations.

### *Streamflow*

A flow effects analysis for Chinook salmon in the lower Sandy River below the Bull Run focused on the potential effects of the City's Bull Run operation on base flows and flow fluctuations (ramping) (CH2M HILL 2002). The analysis used Bull Run flows from 1985 to 2001, which are lower than the HCP flows described in Chapter 7.

**Base Flows.** The City compared the WUA and monthly flow amounts without City operations to the WUA and monthly flows during the 1985 to 2001 period. Although City operations from 1985 to 2001 reduced base flows in the lower Sandy River by 4 to 19 percent (depending on month), the available usable habitat for spring Chinook juveniles in the lower Sandy River was higher for every month. The results were not examined for spawning activity Chinook because the primary spring Chinook spawning areas are upstream of the Marmot Dam site (ODFW 2001). The City's HCP flows will be higher than the flow releases analyzed in CH2M Hill (2002). The City's HCP should maintain or slightly improve habitat conditions in the lower Sandy River for spring Chinook compared with current habitat conditions.

**Downramping.** The CH2M HILL analysis indicates that the downramping rate of 2"/hour would eliminate juvenile salmonid stranding effects in the lower Sandy River reaches.

### *Water Temperature*

Both ODEQ's and the City's water temperature modeling results indicate that the lower Sandy River reaches are in a state of relative equilibrium. City water supply operations have little influence on heating or cooling of the lower Sandy River. This conclusion is supported in the Sandy River Basin TMDL (ODEQ 2005).

Even though the City's operations in the Bull Run will not negatively affect water temperatures in the lower Sandy River, some of the City's offsite conservation measures will probably have small water temperature benefits over existing habitat conditions.

### *Large Wood*

Removal of large wood from the Bull Run reservoirs reduces the amount of large wood loading to downstream Sandy River reaches and reduces channel complexity for spring Chinook. To mitigate for this impact, the HCP includes several large wood measures in the lower Sandy River (see Measures H-4, H-11, H-12, and H-13 in Chapter 7). Installing large log jams in the lower Sandy River (RM 0–RM 18) will slightly increase habitat diversity for migrating spring Chinook. Easements located in prime spring Chinook rearing areas will also improve riparian conditions in the Sandy River. None of the easement areas are in historical condition and as these riparian areas mature, large wood recruitment will increase. Collectively, these measures will improve habitat conditions for rearing or emigrating spring Chinook in the lower Sandy River (see Table 8-17).

### Habitat Effects in the Columbia River from Use of Groundwater

The City will use groundwater from the Columbia South Shore Well Field, in conjunction with the Bull Run River flows, to provide the total amount of water needed to meet water supply demands and the HCP flow commitments. The Columbia River is located adjacent to the well field, so the City analyzed the effect groundwater use might have on flows in the Columbia River.

As context, only one instream flow commitment has been established for the lower Columbia River to maintain the persistence of ESA-listed species. This requirement is the FCRPS's minimum flows of roughly 125,000 cfs below Bonneville Dam, unless competing priorities preclude it (USCOE et. al. 2006). These minimum flows are increased by contributions from the Sandy and Washougal rivers before arriving at the Glenn Jackson Bridge (I-205 bridge), approximately 14 miles west of the mouth of the Sandy River.

The well field has an estimated sustainable capacity of approximately 85 mgd, which is equivalent to approximately 130 cfs. The actual amount and duration of pumping will vary according to the weather and supply conditions, but typically the amount pumped per day would be significantly less than the full capacity. The well field draws on four regional alluvial aquifers. Recharge for these aquifers occurs as far south as the Boring Hills (Hartford and McFarland 1989). These aquifers generally discharge into the Columbia River.

As a simplifying worst case assumption for this analysis, the City assumed that 85 mgd would be pumped from the well field and that this amount would be drawn into the aquifers from the Columbia River. (This is a significant overestimate because the water pumped would actually be drawn primarily or completely from the aquifers themselves and not from the river into the aquifers.) The assumed flow into the aquifers would reduce the assumed flow available in the Columbia River for fish.

If the City's groundwater pumping were to result in a 130 cfs reduction in Columbia River flows, that reduction would be at most 0.1 percent of the total river flow (based on the 125,000 cfs minimum flows mentioned above). To put this reduction in perspective, the typical margin of error on measured flows for the Columbia River is +/- 10 percent (see for example the gauge at the Columbia River at The Dalles, USGS 2003). This measurement error is significantly larger than the estimated flow reduction due to groundwater use. In addition, the mainstem Columbia River has tidal fluctuations that average approximately 1.7 feet (data from USGS Gauge No. 14144700). This natural daily change in river stage is many orders of magnitude greater than any potential reduction of Columbia River flows due to the City's use of groundwater. The City's conclusion is therefore that use of the Columbia South Shore Well Field, as a means to enable the HCP flow commitments in the lower Bull Run River, will have a negligible influence on the Columbia River base flows and associated habitat for spring Chinook salmon migrating in the river.

**Summary of Effects in the Sandy River Basin from the HCP Offsite Measures**

The primary spring Chinook spawning areas are in the upper Sandy River watershed above the Marmot Dam site. The City chose offsite measures to occur in the middle and upper Sandy River, the Salmon River, and the Zigzag River watersheds that have anchor habitat reaches for spring Chinook productivity.

For the middle Sandy, the City will implement measures to benefit spring Chinook, including riparian easements and improvements and large wood placement. Riparian easements will be implemented in the upper Sandy and Salmon rivers and Boulder Creek. In the Salmon River watershed, the City will acquire and restore the Miller Quarry. The City will also implement measures in the Zigzag River watershed to benefit spring Chinook, including reconstructing a natural channel, purchasing riparian easements, and placing salmon carcasses.

The effects of the offsite measures for spring Chinook are as follows:

- The improvements in the Little Sandy River will increase spawning habitat and reduce the risk of peak flow displacement for fry.
- Reduced risk of peak flow displacement, increased cover from predators, reduced impacts from limited food availability, increased rearing and overwintering habitat, and improved habitat diversity will benefit juveniles in the lower and middle Sandy River and Boulder Creek.
- Additional benefits to fish in Boulder Creek include additional spawning habitat and increased channel stability for incubating eggs.
- Small temperature benefits will improve parr productivity and egg incubation in the lower and middle Sandy River segments, respectively.
- In the upper Sandy River, all life stages will benefit from the increase in habitat diversity and the availability of food.
- The improvements in the Salmon River will increase key habitat for fry and overwintering juveniles, reduce bed scour, and provide modest temperature benefits.
- The channel redesign work and riparian easements in the Zigzag River will create additional rearing habitat and increase habitat diversity for fry. Over time, the riparian easements will also provide small temperature benefits.

Details of the specific improvements in spring Chinook habitat that will result from the offsite measures are described in this chapter and in Appendix E. Overall, the City's offsite conservation measures will improve habitat for spring Chinook in the Sandy River Basin.

### Habitat Effects in the Sandy River Basin from the HCP Offsite Measures

The City's HCP includes 30 offsite conservation measures. Most of these measures address environmental problems affecting the production of more than one species. This analysis describes the effects of the HCP measures on spring Chinook. Effects are described by watershed, and both life stages and limiting factors are addressed. (See Chapter 5 for additional information on the spring Chinook salmon population in the Sandy River Basin and the habitat factors limiting production.)

Currently, the primary spring Chinook spawning areas are in the upper Sandy River watershed above the Marmot Dam site (ODFW 2001). Heaviest spawning occurs in the Salmon River below Final Falls Dam (RM 0 – RM 14.0), the lower 4.65 miles of its Boulder Creek tributary, the lower Zigzag River (RM 0 – RM 9.4), the lower 9.4 miles of its Still Creek tributary, and the upper Sandy mainstem above the Salmon River. Some spring Chinook spawn in several mainstem Sandy River tributaries above the Salmon River confluence and in the lower Bull Run River. The City chose some of the 27 offsite measures to occur in primary spring Chinook production areas.

#### *Little Sandy River*

The City's water supply operations do not affect the Little Sandy River because it is a tributary to the lower Bull Run River downstream of the City's dams and diversion. The City's large wood measure for the Little Sandy River was selected to improve habitat diversity for spawning and rearing salmonids but the primary focal species was not spring Chinook because the stream's size, geomorphology, and gradient probably do not favor usage by that species.

The City will place large wood in the Little Sandy River (see Measure H-3 in Chapter 7), which will slightly increase channel complexity and gravel sorting for spring Chinook and other fish species. The City believes that spawning spring Chinook spawning will slightly benefit from the large wood measure because the large wood will trap suitable spawning gravel and provide low-velocity areas for rearing during high flows.

#### *Lower Sandy River Watershed*

The lower Sandy River watershed consists of the 18.5 miles of the Sandy River mainstem between the Bull Run and Columbia river confluences (Sandy 1 and 2 reaches), plus the following tributaries: Beaver, Buck, Gordon, and Trout creeks. Although spring Chinook do not spawn in appreciable numbers in the lower Sandy mainstem or tributaries, they may use the tributaries for non-natal rearing as parr and for overwintering. The use of non-natal tributaries for rearing by spring Chinook is well established when tributaries provide a refuge from high concentrations of suspended sediment in the mainstem (Lestelle et al. 2005). The mainstem Sandy River is a vital migration corridor for all species in the Sandy River Basin.

The HCP offsite measures were selected in spring Chinook production areas with the intent to mitigate effects that cannot be avoided in the Lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The analysis considers beneficial effects for spring Chinook that are likely to result from measures designed primarily for other species.

The City will implement measures in the lower Sandy River to benefit spring Chinook, including a reconnected side channel, reestablished mouth, riparian restoration, and engineered log jams on the lower Sandy mainstem, and large wood placement and riparian enhancements in Gordon and Trout creeks. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

Table 8-18 lists the reaches affected by HCP measures planned in the lower Sandy River and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-18. Habitat Benefits for Spring Chinook in the Lower Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Gordon 1A | Fine sediment in gravel patches | Decrease |
| | Backwater pools | Increase |
| | Large-cobble riffles | Decrease |
| | Pool habitat | Increase |
| | Pool habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Gordon 1B | Backwater pools | Increase |
| | Pool habitat | Increase |
| | Pool-tail habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 1 | Artificial confinement | Reduction |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 2 | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Trout 1A | Large wood | Increase |
| Trout 2A | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

The riparian protection/enhancement projects in the mainstem reaches of the lower Sandy will increase large wood, improve riparian function, decrease confinement in Sandy 1, and improve temperature. A major impact of these measures is the very large increase in the amount of rearing and overwintering habitat provided by the reconnected side channels. Side-channel reconnection is also likely to aid adult passage.

The slow pools in the restored side channels will increase key habitat in Sandy 1 for overwintering juveniles. The combined effect of improved riparian function and increased large wood should significantly improve habitat diversity for parr. Additional large wood will help stabilize the stream channel, lessen peak flow displacement risks to overwintering juveniles, and provide escape cover from predators. Improved riparian function will somewhat reduce temperature impacts, thereby improving parr productivity. Increased riparian function should also lessen impacts attributed to limited food availability and competition with hatchery fish.

Key habitat for juveniles will dramatically increase in the pools, backwater pools, and pool tail-outs in Gordon Creek. Additional rearing habitat should reduce the effects of competition with hatchery fish. Additions of large wood will reduce habitat diversity effects on parr and overwintering juveniles. Gravel retention created by the 300 newly installed log structures will also improve channel stability. The riparian enhancement project on the lowermost reach will stabilize crumbling banks and filter out surface inputs of sediment to spawning substrate.

#### *Middle Sandy River Watershed*

Most of the Middle Sandy mainstem is carved through bedrock in a deep, steep-walled gorge. Spring Chinook primarily use this river segment as a migration corridor (SRBP 2005). The main impact to habitat quality in the mainstem middle Sandy has been Marmot Dam, which is outside the authority of the City and was decommissioned in July 2007.

Upstream of the Marmot Dam site, reach Sandy 6 provides exceptional spawning and rearing habitat with a low gradient, pools, riffles, side channels, and relatively abundant cobble/gravel substrate and large wood. The other reaches provide little habitat for spawning.

The portions of Alder and Cedar creeks that are accessible to spring Chinook support natural spring Chinook productivity. A weir constructed in the early 1950s partially blocks fish passage approximately 0.5 mile upstream from the mouth of Cedar Creek (SRBP 2005).

The City will implement measures to benefit spring Chinook in the middle Sandy River, including riparian easements and improvements, large wood placement, water rights purchases, and carcass placement. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

Table 8-19 lists the reaches affected by HCP measures planned in the middle Sandy River and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-19. Habitat Benefits for Spring Chinook in the Middle Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Cedar 1 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Minimum water temperature | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| Sandy 3 | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Sandy 7 | Carcasses per stream mile | Increase [a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

Riparian easements and improvements in the Sandy River and Cedar Creek will protect intact portions of the riparian corridor, improve the arboreal species composition (by culling hardwoods and planting conifers), and allow for related habitat improvements (such as large wood recruitment and decrease in temperature) to occur over time. Large wood placement will increase channel stability for all life stages, decrease the risk of juvenile displacement by peak flows, and improve habitat diversity. The modest improvement in temperature will improve egg incubation slightly. Salmon carcasses placed in the Salmon River will improve food availability for juveniles.

#### *Upper Sandy River Watershed*

Most of the upper Sandy River watershed is located in the Mt. Hood Wilderness and receives little anthropogenic disturbance. With the exception of the lowermost reach (Sandy 8), spring Chinook production is limited by naturally occurring conditions. The Sandy 8 reach was straightened, cleaned of large wood and large boulders, and confined between riprapped banks in response to the 1964 flood and due to development that had occurred between the communities of Zigzag and Brightwood.

The HCP measure in the upper Sandy River was selected with the intent to mitigate effects on spring Chinook that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river.

The City will implement one measure in the upper Sandy River watershed to benefit spring Chinook—a riparian easement. A detailed description of this measure and the affected reach is presented in Chapter 7. Table 8-20 lists the reach (Sandy 8) affected by HCP measures and the expected habitat benefits (see the tables in Appendix E for percentages for the reference condition and post-implementation values).

**Table 8-20. Habitat Benefits for Spring Chinook in the Upper Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Sandy 8 | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

The improvement in the riparian function and large wood will increase habitat diversity for all holding adults, fry, and parr. Over time, the increase in large wood will create a modest increase in pool habitats of various types, benefiting all three life stages. The carcasses that wash out of the Zigzag River into the Sandy River will boost food production for juveniles.

### *Salmon River Watershed*

Most of the Salmon River watershed supporting spring Chinook spawning consists of the Salmon River reaches below Final Falls Dam (reaches 1, 2, and 3), and the lower 4.65 miles of Boulder Creek (Boulder 0 – Boulder 2 reaches). Reaches 1-3 of the Salmon River are also anchor habitat for spring Chinook (Sandy River Basin Working Group [SRBWG] 2005a).

The HCP measures for spring Chinook production areas were selected with the intent to mitigate effects that cannot be avoided in the Lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The City also considered the habitat factors that are limiting productivity of spring Chinook in a major tributary of the Salmon River, Boulder Creek. The analysis considers beneficial effects for spring Chinook that are likely to result from measures designed primarily for other species.

The City will implement six measures in the Salmon River watershed to benefit spring Chinook, including purchasing riparian easements, acquiring and restoring the Miller Quarry property, adding large wood to Boulder Creek, and adding salmon carcasses to the

Salmon River. A detailed description of each measure and the affected reaches is available by watershed in Chapter 7.

Table 8-21 lists the reaches affected by HCP measures planned in the Salmon River and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-21. Habitat Benefits for Spring Chinook in the Salmon River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Boulder 0 | Fine sediments by surface area | Decrease |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Boulder 1 | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 1 | Off-channel habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 2 | Average depth of bed scour | Reduction |
| | Artificial confinement | Reduction |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 3 | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

The measures affecting the Salmon River reaches will increase key habitat and reduce bed scour. Increased large wood loading, from reconnected side channels and riparian easements, will improve habitat diversity, particularly for fry and overwintering juveniles. Over time, the riparian easements will also improve water temperature, particularly in the lower Salmon River.

Large wood placed in Boulder Creek will increase channel stability for incubating eggs and create pools and spawning habitat. The scouring around artificial log jams and the stability of the gravels collected behind them should improve egg-to-fry productivity and reduce fry displacement during peak flow events. The additional key habitat, habitat diversity, and flow protection will also benefit overwintering juveniles. These benefits are assumed to propagate downstream.

The addition of salmon carcasses in the Salmon River will temporarily improve food availability for fry and overwintering juveniles. The food-related benefits of this action are also assumed to propagate downstream.

### *Zigzag River Watershed*

Most of the watershed supporting spring Chinook consists of three reaches comprising 9.4 miles of the lower mainstem Zigzag River (Zigzag 1A, 1B, and 1C), 9.4 miles of lower Still Creek, and 4.0 miles of lower Camp Creek.

The lower Zigzag River mainstem has been damaged by floods occurring in 1964 and 1972 and by the flood control projects implemented afterwards. The floods scoured the channel and swept large wood downstream, and flood control measures removed the remaining large logs and boulders and deepened and straightened the cleaned channel, which cut off meanders, oxbows, and side channels. Tributaries Still and Camp creeks remain as high-quality spawning and rearing habitat for salmon (SRBP 2005).

The HCP measures were selected in spring Chinook production areas with the intent to mitigate effects that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The analysis considers beneficial effects for spring Chinook that are likely to result from measures designed primarily for other species.

The City will implement measures in the Zigzag River watershed to benefit spring Chinook, including reconstructing a natural channel, purchasing riparian easements, and placing salmon carcasses. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

Table 8-22 lists the reaches affected by HCP measures planned in the Zigzag River and the expected habitat benefits in each reach (see tables in Appendix E for the percentages for reference condition and post-implementation values).

**Table 8-22. Habitat Benefits for Spring Chinook in the Zigzag River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Zigzag 1A | Artificial confinement | Reduction |
| | Harassment | Improvement |
| | Large-cobble riffles | Decrease |
| | Small-cobble riffles | Increase |
| | Pools | Increase |
| | Pool-tails | Increase |
| | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a] |
| | Large wood | Increase |
| Zigzag 1B | Carcasses per stream mile | Increase[a] |
| Zigzag 1C | Carcasses per stream mile | Increase[a] |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

The lower Zigzag channel reconstruction project will essentially restore the stream channel and floodplain to pre-1964 conditions. Resloped stream banks will reduce bank failure; floodplain connectivity and hydraulic connections between the main channel and disconnected oxbows and side channels will be reestablished; a natural meander amplitude and frequency will be restored to the channel; and instream structures will retain gravel. These actions will greatly reduce the degree to which redds are lost due to bedload movement, and will also create additional small gravel riffles and pool tail-outs for spawners.

The “remeandering” of the main channel will reduce stream gradient, thereby reducing water velocity, increasing habitat diversity for fry, and further reducing egg loss due to channel instability. The increased bends and reduced water velocities associated with remeandering will also transform the lower mainstem from a transport reach to a retention reach for large wood, thus increasing habitat diversity for juveniles, creating and stabilizing gravel bars, and scouring new pools. The general reduction of water velocity and bedload movement associated with channel restoration should allow for deposition of gravel-sized particles, thereby transforming large substrate “pocket water” riffles to small cobble/gravel spawning riffles. The reconnection of oxbows and side channels to the main river will provide badly needed habitat diversity and nursery habitat for fry.

The riparian easements and enhancements will protect vital, intact portions of riparian corridor and will improve riparian function by culling hardwoods and planting conifers. Over time, natural improvement in habitat conditions related to riparian vegetation (e.g., habitat diversity, large wood recruitment, security cover, and temperature) will improve.

The placement of 400 salmon carcasses per mile two times in the fall will temporarily improve food availability for spring Chinook juveniles, particularly as the reduced gradient and water velocity and the increased structural complexity of the channel should allow most carcasses to be retained. The benefits of this measure are low as the City is only committing funds to one year of carcass placements.

**Summary of Population Effects and VSP Parameters**

All VSP parameters for the Sandy River population of spring Chinook salmon will be increased by 12–16 percent under the HCP. The projected increases in the VSP parameters should also be considered as modest projections because they do not include any potential benefits to spring Chinook that may be derived from projects supported by the City's $9 million Habitat Fund (see Measure H-30, Chapter 7).

### Population Effects and VSP Parameters

The HCP habitat measures were designed to mitigate the effects of the Bull Run water supply on spring Chinook and other covered species. This section describes the estimated effects of the City's HCP on the overall Sandy River spring Chinook population using parameters established in the NMFS recovery planning process, specifically the work of the LCR-TRT.

Sandy River spring Chinook are designated as a Core Population and a Genetic Legacy and are part of the Lower Columbia ESU (Cascade Zone) (McElhany, et al. 2003). This population is also considered by the LCRFRB (2004) to be a primary population for recovery in the Lower Columbia ESU. Primary populations are those that the TRT believe need to be restored to "High" or "Very High" viability levels in order to recover the species. Spring Chinook have been identified as needing to be restored to a "High" viability level, or 95–99 percent likelihood of persistence (LCRFRB 2004).

The EDT model was used to estimate the benefits for spring Chinook that are likely to result from implementing the HCP, as listed in Table 8-23. Although the model results are not absolute predictions of fish abundance, they do provide a relative comparison of the expected salmon population performance based on the best available science. The inputs to the model represent a combination of site-specific empirical habitat data and, when data were not available, the professional opinion of biologists intimately familiar with the Sandy River ecosystem.

The HCP measures are expected to result in substantial increases in all of the Sandy River spring Chinook VSP parameters. Increases in productivity, diversity, and abundance for spring Chinook are summarized in Table 8-23 and discussed in the following text. These estimates represent increases over what could be expected to result from current habitat conditions in the Sandy River Basin. Improvements in spatial structure are also discussed below. NMFS (in coordination with ODFW) has not yet developed a recovery plan for the

Lower Columbia ESU nor set clear objectives for each VSP parameter; therefore, the significance of these improvements is not yet known.

**Table 8-23. Increases for Spring Chinook Expected Due to HCP Implementation[a]**

| | Productivity | Diversity | Abundance |
|---|---|---|---|
| **Without Cedar Creek Weir Removal** | 12% | 7% | 16% |
| **With Cedar Creek Weir Removal** | 12% | 7% | 16% |

Source: EDT model run April 17, 2007

[a]Estimates do not include benefits from removing the Marmot Dam on the Sandy River.

### *Productivity*

The estimated 12 percent increase in productivity results from increased quality of stream habitat in the Zigzag River, Salmon River, and Sandy River mainstem. This is a relatively substantial increase in productivity that should result in higher adult returns over time.

### *Diversity*

The estimated 7 percent increase in life history diversity represents improvements in habitat conditions over time and space. Most of this improvement occurs in the Salmon River, Zigzag River, and Sandy River mainstem. Lesser improvements in spring Chinook diversity are produced in the Bull Run River.

### *Abundance*

The estimated 16 percent improvement in adult spring Chinook abundance in the Sandy River Basin results from the increases in productivity and diversity. Increased abundance reduces extinction risk for the population. Higher abundance also results in increased ecological benefits. Salmonids improve both their physical and biological environments through various mechanisms. For example, adult spawners reduce fine sediment concentrations in gravels, and their carcasses provide a food source for other aquatic and terrestrial species.

Although the LCR-TRT has not yet established recovery goals for Sandy River spring Chinook, others have indicated that the Sandy River Basin has the potential to produce up to 5,200 adults (LCRFRB 2004). The City's HCP makes a significant contribution toward achieving this objective.

### *Spatial Structure*

The viability of a salmon population depends not only on the population's productivity, abundance, and diversity, but also on its spatial structure (McElhany et al. 2000). The more watersheds in a basin that contain large numbers of spawners, the less likely that catastrophic events, such as landslides or human caused disasters, will result in the extinction of the population

Sandy River spring Chinook currently spawn primarily in the Salmon, Zigzag, and middle and upper Sandy River watersheds. Historically, this species was also found in the Bull Run River and may have spawned in small numbers in the lower Sandy River. The HCP actions will not increase access for spring Chinook in the Sandy River Basin. However, the actions will improve habitat in primary spawning and rearing areas for spring Chinook.

Because the upper Bull Run River is no longer accessible to spring Chinook, the actions in the HCP were spread out across the majority of the current distribution area. Offsite habitat improvement actions will be implemented in the lower and middle Sandy, Salmon, and Zigzag river watersheds. Habitat improvement projects that are expected to increase adult run size will also be implemented in the lower portion of the Bull Run.

The City's actions are designed to improve riparian condition, increase the amount of large wood, open blocked habitat, or increase streamflow in four of the five watersheds where spring Chinook historically ranged. Because the combination of HCP actions targets all of the spatial structure objectives, the City's plan will likely improve this VSP parameter for spring Chinook.

Improved habitat conditions in the Bull Run, Salmon, and Zigzag rivers, and the entire mainstem Sandy River increase the viability of the spring Chinook population. A complete loss of spawners in one of these watershed populations from a catastrophic event, although significant, would not result in population extinction because fish from the other watersheds would be able to recolonize this habitat over time.

Table 8-24 summarizes the population effects of the HCP measures on spring Chinook by the VSP parameters of abundance, productivity, diversity, and spatial structure.

**Table 8-24. Effects of the HCP Measures on Sandy River Basin Spring Chinook Populations, by Viable Salmonid Population (VSP) Parameters**

| VSP Parameter | Reference Condition | Effect of Conservation Measures |
|---|---|---|
| Abundance | Current habitat conditions | Spring Chinook abundance for the Sandy River population is projected to increase by 16%. |
| Productivity | Current habitat conditions | Productivity for the Sandy River spring Chinook population is projected to increase by 12%. |
| Diversity | Current habitat conditions | Diversity for the Sandy River population is projected to increase by 7%. |
| Spatial Structure | Current habitat conditions | Spatial structure improves as actions are focused on increasing spawner abundance in all of the five watersheds historically occupied by spring Chinook. Increased adult abundance in multiple watersheds reduces effects of catastrophic events, which reduces extinction risk. |

Sources: EDT model run April 17, 2007 for abundance, productivity, and diversity percentages; for spatial structure assessment, Kevin Malone, personal comm. 2006

### Summary Comparison of Fish Abundance

The projection of adult spring Chinook abundance under the City's HCP is greater than the benchmark comparison scenario established for the Bull Run watershed.[8] This benchmark comparison indicates that the HCP will produce enough beneficial habitat changes for spring Chinook salmon to offset all potential impacts that could be caused by the City's water supply operations in the Bull Run.

### Population Effects and Benchmark Comparison of Fish Abundance

The introduction to this HCP chapter describes a benchmark scenario the City developed to compare results of the HCP measures with production potential of the Bull Run River (see Section 8.1.1). The EDT model was used to generate the estimated abundance of spring Chinook and to compare the benchmark against the benefits of the City's HCP measures. The City believes that the Modified Historical Bull Run Condition estimate represents generous assumptions and the HCP estimate is an underestimate of probable HCP results (see Section 8.1.1).

Model results indicate that the HCP measures would improve habitat sufficiently to match or exceed the production potential of the Modified Historical Bull Run Condition (see Table 8-25).

**Table 8-25. Model Results for Spring Chinook Abundance: Modified Historical Bull Run Condition Compared with HCP Measure Implementation[a]**

| Scenario | Adult Abundance |
|---|---|
| Modified Historical Bull Run Condition | 6,489 |
| HCP Measures Without Cedar Creek | 6,798 |
| HCP Measures With Cedar Creek | 6,798 |

Source: EDT model run April 17, 2007

[a]Estimates do not include benefits from removing the Marmot Dam on the Sandy River.

The City believes these results help demonstrate that the HCP will provide the benefits for spring Chinook necessary to meet the ESA Section 10 requirements. However, the City does not propose to use EDT population estimates as an enforceable performance measure for spring Chinook. The City's HCP is purposefully habitat based. It is designed using measurable objectives, monitoring, and adaptive management triggers that relate to habitat condition, as described in other chapters of this document.

[8] See the subsection Sandy Basin Population Effects under Section 8.1.1 for an explanation of the benchmark comparison of fish abundance in the Bull Run watershed.

### Conclusions about the Habitat Effects of HCP Measure Implementation

- **Effects in the Lower Bull Run River.** All of the HCP measures in the lower Bull Run River will benefit spring Chinook salmon. These measures avoid or minimize ongoing City impacts in the Bull Run River (as described in Table 7-1) to the maximum extent practicable. Impacts associated with blocked fish access to the upper watershed, reduced base flows, and elevated water temperature during spawning will not be completely addressed in the Bull Run but will be mitigated by offsite measures in the Sandy Basin. The benefits provided by the Bull Run HCP measures are summarized in Table 8-12.
- **Effects in the Sandy River Watersheds.** Substantial additional benefits for spring Chinook are provided by HCP measures in the upper Sandy River and its tributaries (e.g., Salmon and Zigzag rivers), the middle Sandy Basin, and the lower Sandy Basin. The upper Sandy has the primary spawning areas for spring Chinook in the Sandy River Basin and all anchor habitat reaches for spring Chinook are located in these areas. The primary limiting factors for spring Chinook for those areas include a lack of key habitat quantity and diversity, reduced channel stability and side-channel habitat, and reduced large wood levels. HCP measures H-18, H-19, H-20, H-21, H-23, H-24, H-27, H-28, and H-29 are targeted to address those limiting factors around the upper Sandy. Spring Chinook also use the mainstem Sandy River upstream and downstream of the Bull Run for juvenile rearing and migration. Measures in the middle and lower Sandy Basin benefit spring Chinook by improving riparian zone conditions through time and increasing large wood levels. Benefits provided by the offsite measures are summarized in Tables 8-18, 8-19, 8-20, 8-21, and 8-22, and in Appendix E, Tables E-5 and E-6.
- **Timing for Implementing Measures.** The timing for implementing measures relevant to spring Chinook and other species is provided in Tables 7-6 through 7-12. Measures in the upper and middle Sandy River are primarily scheduled for HCP Years 6-15. The City will be conducting effectiveness monitoring for the instream measures; the objective in those cases is to accrue 80 percent of the predicted habitat change within 15 years of implementing each measure (see Chapter 9).
- **Population Response.** Although the HCP is not intended to guarantee specific population responses, implementation of the HCP is expected to result in improved population conditions for spring Chinook. Table 8-24 describes the anticipated increases of the four VSP parameters: abundance, productivity, diversity, and spatial structure. The estimated population response compared to the Modified Historical Bull Run Condition also indicates that implementation of the HCP will likely result in a population response greater than the production potential in the Bull Run watershed. Neither of these estimates includes the habitat or population benefits that will result from the $9 million Habitat Fund.
- **Accumulation of Habitat Benefits.** The HCP conservation measures will accumulate benefits for spring Chinook at varying rates. Figure 8-10 describes the accumulation of benefits over the 50-year HCP term and the figure is based on EDT model results. The figure shows the predicted increase in adult spring Chinook abundance that could result from the habitat changes. Benefits are organized according to three general categories of

HCP measures: flow, instream actions, and riparian easements. Fish passage improvements for Cedar Creek are not anticipated to benefit spring Chinook. The City assumes that the benefits from large wood additions would only contribute to adult spring Chinook abundance for the first 15 years of their project life. This is a very conservative assumption because it is likely that the wood will be in the various stream reaches beyond 15 years and adding some habitat value for fish. Other instream actions, such as the opening of side channels and riprap removal, are considered permanent for the purpose of the HCP. Riparian easements are assumed to take 15 years before beginning to provide benefits and would not provide full benefits until 30 years after implementation. Flow measures will provide habitat for spring Chinook starting in Year 1 of the HCP.

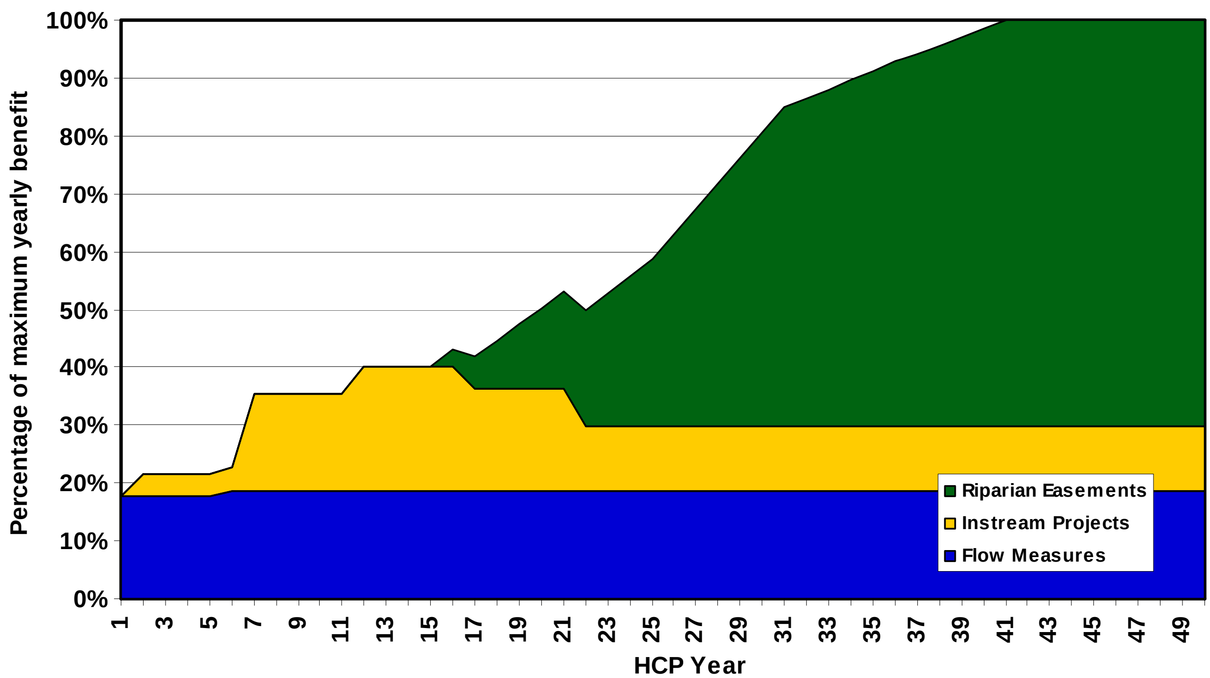


**Figure 8-10. Accumulation of Predicted Benefits to Spring Chinook from HCP Measures Over Time[a]**

Source: EDT model runs, April 10, 2007.

[a]The accumulated benefits exclude benefits from the following measures: H-3—Little Sandy 1 and 2 LW Placement, P-2—Alder 1 Fish Passage, P-3—Alder 1A Fish Passage, H-25—Salmon 2 Carcass Placement, H-29—Zigzag 1A, 1B, and 1C Carcass Placement

The full spring Chinook benefits would be realized by approximately HCP Year 40. This maximum benefit level closely corresponds to the abundance number used in Table 8-25 for the "HCP Measures with Cedar Creek" scenario, but the benefit level excludes the benefits of large wood additions. Through the term of the HCP, the cumulative total benefits will be 29 percent from the flow measures, 19 percent from instream measures, and 52 percent from riparian easements.

**The City believes the HCP, as a whole, meets ESA Section 10 requirements for spring Chinook.**

### 8.2.3 Winter Steelhead Habitat Effects

The HCP measures in the Bull Run watershed minimize the effects on juvenile and adult steelhead in the lower Bull Run River to the maximum extent practicable. Offsite measures were selected to provide additional benefits for steelhead to help mitigate for the effects not avoided in the Bull Run. In addition, offsite measures that mitigate for impacts on other covered species also provide benefits for steelhead. Chapter 11 describes the City's commitment to fund the implementation of the necessary measures.

The City recognizes that winter steelhead and resident rainbow trout are the same species and that their habitat requirements are similar. The effects of all HCP measures on winter steelhead and rainbow trout are assumed to be substantially the same, with the exception of effects on rainbow trout in the Bull Run reservoirs. Effects that specifically affect rainbow trout in the Bull Run reservoirs are described in Section 8.4.1, Rainbow Trout.

The potential effects of the City's Bull Run water supply operations on winter steelhead in the Sandy River Basin are described in six subsections:

1. Effects in the lower Bull Run River— Describes the habitat effects of both the City's water supply operations and the HCP measures on lower Bull Run habitat for winter steelhead
2. Effects in the lower Sandy River—Describes the habitat effects of both the City's water supply operations and the HCP measures on habitat in the lower Sandy River for winter steelhead
3. Effects in the Columbia River— Describes the effects of using the City's groundwater supply at the Columbia South Shore Well Field on fish habitat in the Columbia River
4. Effects in Sandy River Basin watersheds—Describes the habitat effects of the offsite HCP measures on winter steelhead habitat in watersheds of the Sandy River Basin
5. Effects on the Sandy River populations, by VSP parameter—Describes the population effects of all of the HCP measures (those in the Bull Run and those in the Sandy River Basin offsite locations) on abundance, productivity, diversity, and spatial structure for winter steelhead
6. Comparison to a population benchmark—Compares estimates of winter steelhead abundance under historical conditions to estimated abundance after HCP implementation

Summaries for all subsections appear in gray shaded boxes. A detailed description of the effects for the species in the geographic location follows each summary. Conclusions about the habitat effects on winter steelhead from implementation of all HCP measures, including a discussion of the predicted accumulation of habitat benefits over time, are provided on page 8-114.

**Summary of Effects on Winter Steelhead in the Bull Run Watershed from Bull Run Water Supply Operations and HCP Measures**

The City identified 10 types of effects that the conservation measures will have on steelhead in the Bull Run Watershed. The City also analyzed the potential impacts on the base flow of the Columbia River from the HCP flow commitments.

- Impacts associated with fish access to the upper watershed, low base flows, and low weighted usable areas will be reduced with the Bull Run conservation measures, but not all impacts will be avoided. Impacts that are unavoidable will be offset by the Sandy offsite conservation measures.
- The Little Sandy River flow commitment will increase habitat for steelhead for the term of the HCP.
- Impacts on spawning gravel, flow downramping, and riparian function will be avoided by the measures.
- There will be some short-term negative water temperature impacts, but long term, the natural thermal potential of the lower river will be returned by the City's infrastructure and operational changes for its dams and reservoirs.
- The removal of large wood at the reservoirs is considered a small impact to steelhead because the species depends on coarse gravel for hiding and resting habitat.
- The City does not know whether TDG levels harm steelhead in the lower Bull Run, but TDG levels will be monitored under this HCP and addressed through adaptive management provisions described in Chapter 9.
- The City's flow measures will have an extremely small effect on the Columbia River base flows, and steelhead habitat will not be affected.

Table 8-26 summarizes the effects of the water supply operations, the reference condition for the effect, and the predicted effects of the City's HCP conservation measures in the Bull Run watershed.

**Table 8-26. Effects of the Bull Run HCP Measures on Lower Bull Run River Habitat for Steelhead[a]**

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base flows<br>Winter/Spring Period (spawning, egg incubation, fry emergence, and rearing)<br>Summer Period (rearing) | Natural Bull Run base flows | Projected HCP flows will be 77–81% of natural base flows during the winter/spring spawning, incubation, and fry rearing period.<br>Projected HCP flows will be 36–46% of natural base flows during the summer rearing period. |
| Weighted Usable Area (WUA)<br>1. Winter/Spring Spawning<br>2. Summer Juvenile Rearing | Natural flow<br>Weighted Usable Area | 1. HCP WUA's for spawning will exceed the maximum WUA levels. All impacts will be avoided.<br>2. HCP WUAs for summer juvenile rearing will be 70–100% of the maximum WUA value. |
| Flow Downramping | Protective downramping rate: 2"/hour | The City will meet the protective downramping rate (2"/hour) and fish stranding effects will be minimal. |
| Little Sandy River Base flows | Natural flow; free-flowing | City's commitment to forgo development of the Little Sandy water rights will ensure free-flowing conditions for approximately 10 new miles of stream habitat in the Little Sandy River. |
| Water Temperature | ODEQ standard: natural thermal potential | There will be minor, short-term water temperature impacts prior to installation of infrastructure improvements at Dam 1. Once the infrastructure improvements are in place, City will meet the natural thermal potential of the lower Bull Run River. |

**Table 8-26. Effects of the Bull Run HCP Measures on Lower Bull Run River Habitat for Steelhead[a], continued**

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Large Wood | Natural wood routing and accumulation | The City will allow the natural occurrence of large wood downstream of Larson's Bridge. The large wood will slightly benefit the habitat for rearing steelhead. The improvements will be modest because juvenile steelhead prefer coarse gravel for hiding habitat and finding lower water velocity areas. |
| Spawning Gravel | Natural levels of gravel recruitment | The City will replace the natural level of gravel recruitment in the lower Bull Run River. All impacts will be avoided. |
| Fish Access | Historical fish anadromy<br>Total blocked stream miles in the Bull Run River watershed: 42<br>Blocked free-flowing miles in the Bull Run River watershed (excluding the Little Sandy River): 25 | City will not provide access into the upper Bull Run River.<br>Approximately 10 miles of river will be provided in the Little Sandy River, all of which could be used by winter steelhead. Additional stream miles for winter steelhead will be provided under the City's offsite habitat measures. |
| Riparian Function | Mature riparian zones | City's riparian lands along the lower Bull Run River are currently in good condition. Protective measures in the HCP will maintain and somewhat improve these conditions as younger trees mature. |
| Total Dissolved Gases (TDG) | ODEQ standard: maximum of 110% saturation at flows below the 7Q10 flow | The City does not believe there are elevated TDG levels in the current range of anadromy at flows below the 7Q10 flow, but the City will continue to monitor to determine whether the ODEQ standard is being met. |

[a]For the list of conclusions about the habitat effects of all HCP measures on winter steelhead, see page 8-114.

### Habitat Effects in the Bull Run Watershed from Bull Run Measures

Effects on winter steelhead in the lower Bull Run River are described in the following categories: streamflow, water temperature, large wood, spawning gravel, access, riparian function, and TDG.

#### *Streamflow*

The City's analyzed streamflow effects on winter steelhead by two means: comparing the effects of the HCP Bull Run base flows with the natural (pre-water-system) conditions, and determining the winter steelhead spawning and rearing WUA likely to result from Bull Run flow measures.

**Bull Run Base Flows.** The City compared an estimate of median monthly flows (50 percent exceedance flows) under natural conditions (i.e., no dams or diversions in the Bull Run watershed) with anticipated future flows during implementation of the HCP, assuming normal and critical years occur at the same frequency in the Bull Run as they have in the past. A 64-year hydrological record (1940–2004) was used for the analysis. The estimated median flows for the Bull Run River upstream of the Little Sandy River are shown in Figure 8-11; all flow amounts are relative to the USGS Gauge No. 14140000 located at RM 4.7 on the Bull Run River. The flow analysis considers winter steelhead utilization of habitat in the lower Bull Run River, as shown in Figure 8-11 and consistent with the periodicity chart in Chapter 5 (Figure 5-27).

Table 8-27 shows the median natural flows and median flows anticipated from implementing the HCP. The comparison is for flows in two segments: upstream of the confluence with the Little Sandy River (RM 3.0—RM 5.8), and downstream of the Little Sandy River (RM 0–RM 3.0). For the portion of the Bull Run River downstream of the Little Sandy River, median flows were determined using the estimated Little Sandy median natural flows that would occur after the Little Sandy Dam is removed.

Photo courtesy of Bonneville Power Administration.

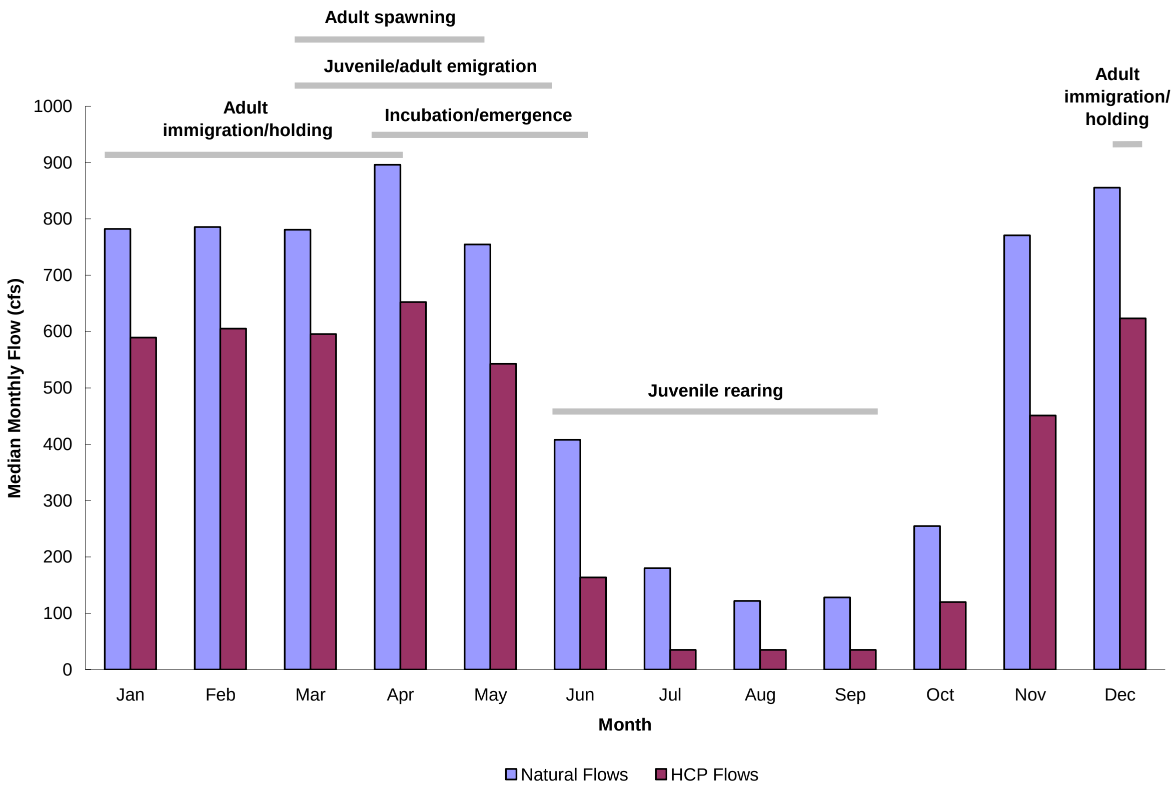


**Figure 8-11. Median Monthly Flows and Peak Periods of Occurrence for Steelhead in the Lower Bull Run River above the Little Sandy River Confluence[a]**

Source: Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000 (RM 4.7).

[a]Although peak juvenile rearing period is shown here, steelhead rearing occurs all year. See Figure 5-27 for periods of occurrence in the lower Bull Run River.

**Table 8-27. Natural and HCP Median Flows by Month for the Lower Bull Run River**

| | Flows above Little Sandy (cfs)[a] | | Flows below Little Sandy (cfs)[b] | |
|---|---|---|---|---|
| **Month** | **Natural** | **HCP** | **Natural** | **HCP** |
| **January** | 782 | 611 | 938 | 765 |
| **February** | 785 | 608 | 957 | 776 |
| **March** | 780 | 606 | 932 | 760 |
| **April** | 896 | 672 | 1,072 | 846 |
| **May** | 755 | 563 | 898 | 709 |
| **June** | 408 | 196 | 487 | 274 |
| **July** | 180 | 35 | 213 | 67 |
| **August** | 122 | 35 | 141 | 54 |
| **September** | 128 | 35 | 152 | 55 |
| **October** | 255 | 120 | 304 | 166 |
| **November** | 771 | 427 | 924 | 608 |
| **December** | 857 | 654 | 1,031 | 829 |

[a]Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7).

[b]The sum of median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7) and median monthly flows taken at USGS Gauge No. 14141500, Little Sandy River (RM 1.95).

Upstream of the Little Sandy River confluence, median HCP flows will be approximately 77 percent of the natural flow (see Table 8-27) from January through May. Downstream of the Little Sandy, median HCP flows will be 81 percent of the natural flow.

**Effects of Bull Run Flows on Winter Steelhead Spawning.** The primary spawning period for wild winter steelhead is March to May (Figure 5-18) (ODFW 2001). R2 Resource Consultants (1998) indicated that near-optimal spawning conditions for winter steelhead occurred between flows of 130 and 200 cfs. With the minimum HCP flow of 120 cfs, the predicted median flows in the lower Bull Run River above and below the confluence with the Little Sandy River would range from approximately 550 to 850 cfs from March to May (see Table 8-27), providing ideal spawning and incubation conditions.

**Effects of Bull Run Flows on Winter Steelhead Rearing.** Flows during the summer and early fall will have moderate effects on juvenile rearing. Upstream of the Little Sandy River, the projected HCP flows will be 36 percent of the natural flows during June through September. Downstream of the Little Sandy confluence, the projected HCP flows will be 46 percent of natural flows. The significance of these flow differences is discussed below in terms of WUA for rearing winter steelhead.

**Bull Run Weighted Usable Area.** WUA values were calculated from median flows for winter steelhead spawning and rearing to assess the effect of the HCP flow measures on lower Bull Run River habitat. Table 8-28 compares WUA estimates for natural flow conditions (no dams and no diversions) with estimates of HCP flows, upstream and downstream of the Little Sandy River confluence.

R2 Resource Consultants (1998) estimated the flow-habitat relationships for spring Chinook spawning and juvenile rearing in the Bull Run River. Using the PHABSIM model, they generated estimates of WUA for up to 500 cfs in four segments of the Bull Run River. The four segments were combined into the two segments of the lower Bull Run River: upstream and downstream of the Little Sandy River. For flows greater than 500 cfs, goodness-of-fit curves were used to extrapolate WUA values.

The WUA estimates for natural and HCP flows are compared using a “percentage of natural” metric. For example, if the HCP percentage of natural flow is 90 percent, the HCP median flow will yield a WUA value of 0.9 acre in a month, and the WUA value would be 1.0 acre in a month.

**Estimated WUA for Spawning.** During the primary winter steelhead spawning period from March to May, the City’s HCP minimum flow of 120 cfs will maintain good conditions for spawning and incubation. The City’s predicted median flows in the lower Bull Run River would range from approximately 550 to 850 cfs (see Table 8-27). R2 Resource Consultants (1998) indicated that flows between 130 and 200 cfs create near-optimal conditions for creating total usable habitat values (WUA) for spawning steelhead (see Figure 5-29).

The HCP also includes a provision to reduce flows in the fall during water years with critical seasons (see Measure F-2 in Chapter 7). The frequency of these reductions will be limited by the City’s commitment. Critical fall flows will only occur in 10 percent of the HCP years. The City’s commitment will also limit the occurrence of critical fall flows to no more than two consecutive years. If critical fall flows are triggered, the City will not release critical fall flows in a specific year when most of the resulting adult fish would return to their place of origin. When a critical fall flow year occurs, the City will not implement critical fall flows four years later regardless of whether the critical fall trigger occurs. The reductions in flows during critical fall flows will not affect steelhead because the species does not spawn in the fall. The Bull Run River flows in the fall under the HCP will still provide good habitat for rearing steelhead (see WUA for Rearing below).

**Estimated WUA for Rearing.** Steelhead rear in the lower Bull Run from June through September. The guaranteed minimum HCP flow in the summer is 20 cfs, although flows can vary from 20–40 cfs. The projected median flow varies from 35 for low flows above the Little Sandy River to 274 cfs for high flows below the Little Sandy River. R2 Resource Consultants (1998) estimated that habitat area (WUA) for winter steelhead increases at a rapid rate with flows between 0 and 100 cfs, with the most rapid increase occurring between 0 and 20 cfs (see Figure 5-30). Under the City’s HCP flows, the WUA values range from approximately 70 to 100 percent of the estimated natural flow WUA values for June through September (Table 8-28).

**Table 8-28. Comparison of Winter Steelhead Median Flows and Juvenile Rearing Weighted Usable Area (WUA) Values**

| Month | Natural Flow (cfs) | HCP Flow (cfs) | Natural Flow WUA | HCP Flow WUA | Percentage of Natural Flow WUA |
|---|---|---|---|---|---|
| *Above the Little Sandy River (Upper Section)* | | | | | |
| June | 408 | 196 | 14.32 | 14.68 | >100 |
| July | 180 | 35 | 14.56 | 9.77 | 67 |
| August | 122 | 35 | 13.93 | 9.77 | 70 |
| September | 128 | 35 | 14.02 | 9.77 | 70 |
| *Below the Little Sandy River (Lower Section)* | | | | | |
| June | 487 | 274 | 14.46 | 14.88 | >100 |
| July | 213 | 67 | 14.54 | 10.83 | 74 |
| August | 141 | 54 | 13.46 | 10.13 | 75 |
| September | 152 | 55 | 13.77 | 10.19 | 74 |

Source: EDT model run April 17, 2007

**Bull Run Peak Flows.** The City assessed effects on peak flows in the lower Bull Run River by evaluating the annual peak winter flows since Water Year 1960. This data set was used for the peak flow analysis because the USGS gauge was in another location prior to 1960. The City estimated peak winter flows in the absence of the City's water supply diversions, peak winter flows with current (2006) water diversions, and peak winter flows with estimated 2025 water diversions based on Metro's population projections. The estimated change in annual total water yield diverted for supply is expected to increase from 20 percent currently to 22 percent in 2025.

The estimated magnitude of the annual peaks with no water diversions ranged from 4,010 to 25,420 cfs, depending on weather conditions. The estimated magnitude of the annual peaks for current water demands ranged from 3,880 to 25,100 cfs. The estimated magnitude of the annual peaks for 2025 water demands ranged from 3,863 to 25,094 cfs. Differences were determined by comparing flows on individual peak flow dates. The differences between no diversions and current diversions ranged from 0.3 percent to 3.3 percent. The differences between no diversions and estimated 2025 diversions ranged from 0.6 percent to 3.7 percent.

The City also characterized each peak flow event into a return frequency category (i.e., less than 2-year event, 2-5 year event, 5-10 year event, 10-25 year event, 25-50 year event, and 50-100 year event). The flow conditions experienced in those events were applied to current water diversions and 2025 estimated water diversions. In only one case did the increase in winter season water diversions in 2025 cause a change in the return frequency category for peak events. The January 5, 1969 weather year changed from a slightly greater than 2-year event to a slightly less than 2-year event.

The City concluded from this analysis that implementation of the HCP will not significantly change the magnitude of peak flow events in the lower Bull Run River. Peak flow events will continue to occur with a frequency and magnitude similar to current conditions and similar to conditions that would occur without water supply diversions.

**Bull Run Flow Downramping.** The City's hydroelectric plant at the base of Dam 2 varies the streamflow in the lower Bull Run River during the winter and spring months when there is enough streamflow to run the facility. The current FERC license allows for a 2'/hour downramping rate for the lower Bull Run River, but the City is committing to a lower rate to protect juvenile salmonids.

The City has studied juvenile salmonid stranding during downramping events in the lower Bull Run River (Beak Consultants 1999; CH2M HILL 2002). The sites selected for monitoring included the widest areas of the channel considered most sensitive to ramping effects and stranding. Winter steelhead fry (about 40 mm average length) and yearlings (Age-1) juveniles were observed during the studies. Based on the studies, a ramping rate of no more than 2"/hour was recommended for the lower Bull Run River. This rate is generally what the state of Oregon and others have recommended to protect against juvenile fish stranding (CH2M HILL 2002; Hunter 1992).

The City will minimize the risk of fish stranding by maintaining a maximum downramping rate of 2"/hour year-round for the hydroelectric powerhouse downstream of Bull Run Dam 2. All effects from flow downramping, however, cannot be avoided due to certain circumstances beyond the control of the City.

The City conducted a year-long evaluation of downramping (Galida 2005) and determined that circumstances when the City would not meet the ramping rate occurred 0.4 percent of the time, which will have minimal effects on winter steelhead. These circumstances included natural storm flows, mechanical/control system failures that are impossible to predict, and FERC mandatory testing of project safety equipment. Out of the test period of approximately 8,800 hours of hydropower operations, the 2"/hour downramping rate was exceeded only for 35 hours. The exceedances occurred from mid-November through late-March and streamflow in the lower Bull Run River was 200-12,600 cfs. Natural streamflows were quite variable and since the reservoirs were full, the downramping rate could not be controlled by the City for approximately one third of the 35 hours. Other exceedances can be attributed to equipment testing and operator error. Overall, the City was very successful in controlling the downward fluctuation of the lower Bull Run River.

The City's commitment to a downramping rate of 2"/hour will result in minimal effects on steelhead. The occurrences of downramping greater than 2"/hour will rarely occur in the future, and if they do, they will happen during the winter months. The primary spawning period for winter steelhead in the Bull Run is February though mid-May (see Chapter 5), and near-optimal conditions for spawning and egg incubation occur between flows of 130 and 200 cfs (R2 Resource Consultants 1998). All downramping rate exceedances (>2"/hour) that the City observed were during flows greater than 200 cfs, and spawning/incubation of steelhead will not be harmed with the City's downramping measure. Also, there will be a very low potential for stranding juvenile steelhead because the higher downramps would occur only infrequently and sporadically during the late winter and early spring. Vulnerable steelhead fry (<40 mm) would be out of the gravel and susceptible to stranding only by late May and June. The City would shut down hydropower operations at Dam 2 during that time of year because reservoir inflows would be rapidly decreasing.

The City will continue to monitor downramping in the lower Bull Run as part of the compliance monitoring efforts (see Chapter 9).

**Little Sandy River Base Flows.** Foregoing development of the City's water rights on the Little Sandy River during the term of the HCP will help assure unimpeded natural flows on the Little Sandy River for winter steelhead. Winter steelhead will have access to approximately 7.3 river miles of the mainstem Little Sandy and approximately 2 miles of tributary habitat. This measure will significantly increase the spawning and rearing habitat for winter steelhead. These flows also contribute to higher flows in the lower Bull Run River below the Little Sandy confluence, as indicated in Tables 8-27 and 8-28.

### *Water Temperature*

Winter steelhead utilize the Bull Run River year-round and most of the year the water temperatures are generally cool and acceptable for the species (see Figure 8-12). The species spawns in the lower Bull Run in the spring, emerges from the gravel in early summer, and rears throughout the year (see Figure 5-22 in Chapter 5). The only time of the year when the water temperatures are too warm for the species is during the summer and early fall.

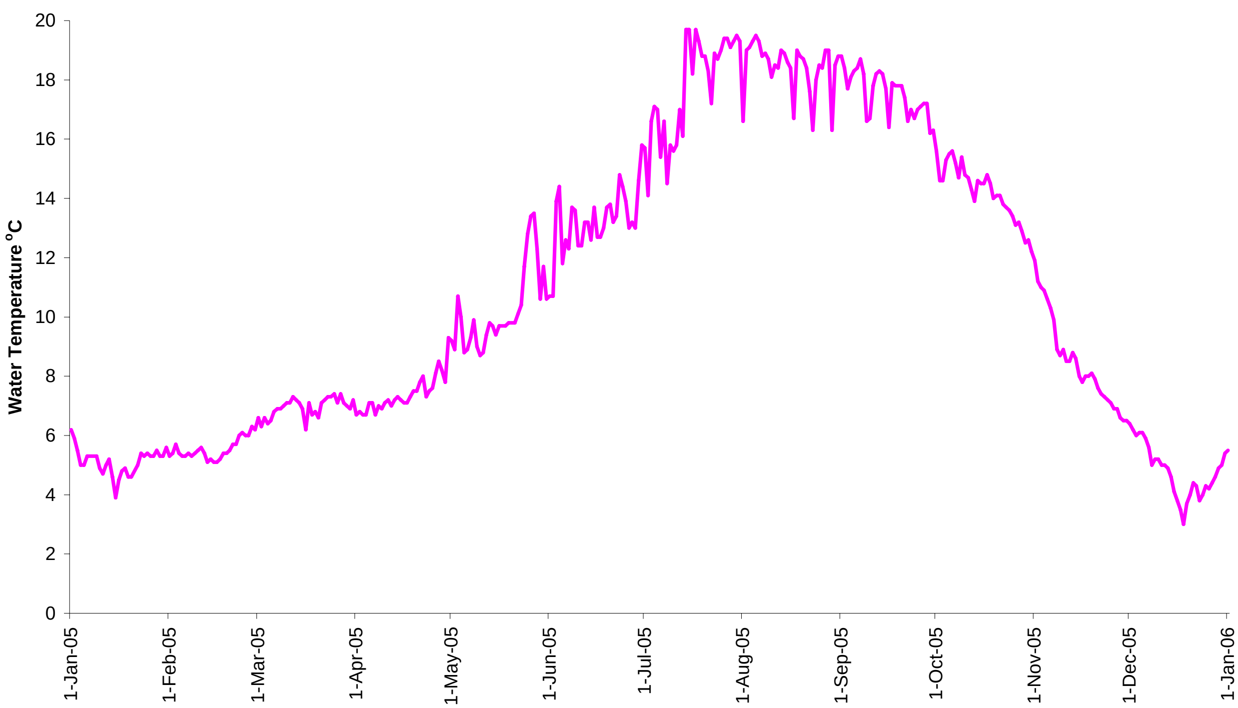


**Figure 8-12. 2005 Daily Maximum Water Temperatures for the Lower Bull Run River as Measured at USGS Gauge No. 14140000 (RM 4.7)**

Source: USGS Gauge No. 14140000 on the Bull Run River (RM 4.7).

The reference condition for water temperature is the natural thermal potential of the lower Bull Run River. Natural thermal potential is defined by ODEQ in the Sandy River TMDL (ODEQ 2005) as the water temperatures that would occur in the Bull Run River if there were no dams or diversion. The City, in conjunction with ODEQ, developed a method to determine the natural thermal potential of the lower Bull Run River and found that the current temperature regime of the Little Sandy River is a good surrogate for the Bull Run. (See temperature measure T-2 in Chapter 7 for more details.)

**Pre-infrastructure Water Temperature Effects.** The City plans to make significant infrastructure improvements at Dam 2 to meet the natural thermal potential of the lower Bull Run River. However, prior to completion of the infrastructure improvements, water temperatures in the lower Bull Run River during the summer and September-October will exceed those preferred for rearing steelhead (see Figure 8-13).

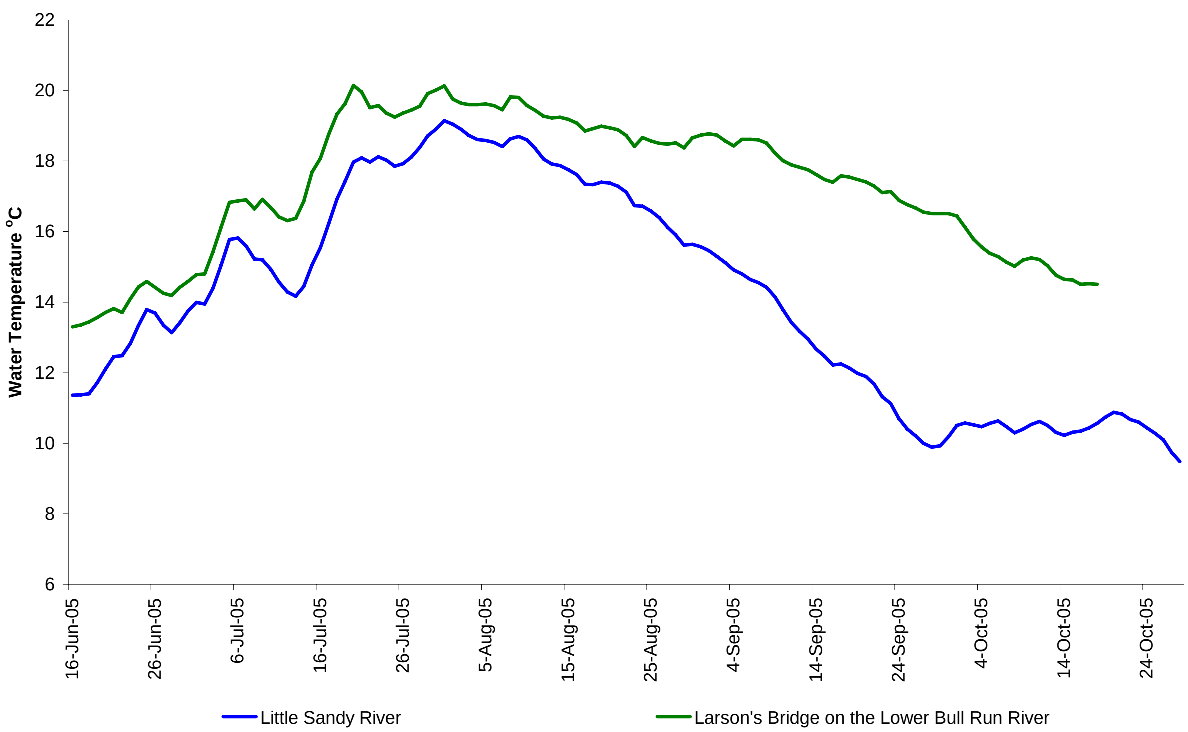


**Figure 8-13. 7-Day Maximum Average Water Temperatures for the Little Sandy and Lower Bull Run Rivers, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and USGS Gauge No. 14140000 on the Bull Run River (RM 4.7).

The City will continue to carefully manage the amount of cool water in the reservoirs for downstream flow releases. Figure 8-14 indicates the water temperature performance that the City will be able to achieve in the first years of the HCP. For rearing steelhead in the summer and early fall, the City has established the interim goal of not exceeding 21 °C at Larson's Bridge on the lower Bull Run River. That target is cool enough to allow continued growth of steelhead. While this temperature target is higher than the preferred range by rearing steelhead, it is the best performance outcome that the City can achieve with the current dam infrastructure. There will be some temporary effects on steelhead juveniles.

**Post-infrastructure Water Temperature Effects.** The City will complete infrastructure changes at the Dam 2 towers and the stilling basin and commit to daily operational flow management (Measure T-2). The City used the CE-QUAL-W2 water quality model to predict natural condition stream temperatures in the lower Bull Run River (City of Portland 2004). The model predicted that maximum stream temperatures would occur at Larson's Bridge (RM 3.8) in the lower Bull Run River. City staff and ODEQ staff evaluated modeling results and empirical data and concluded that natural stream temperatures in the lower Bull Run River could be estimated using the stream temperature of the Little Sandy River (see Figure 8-14).

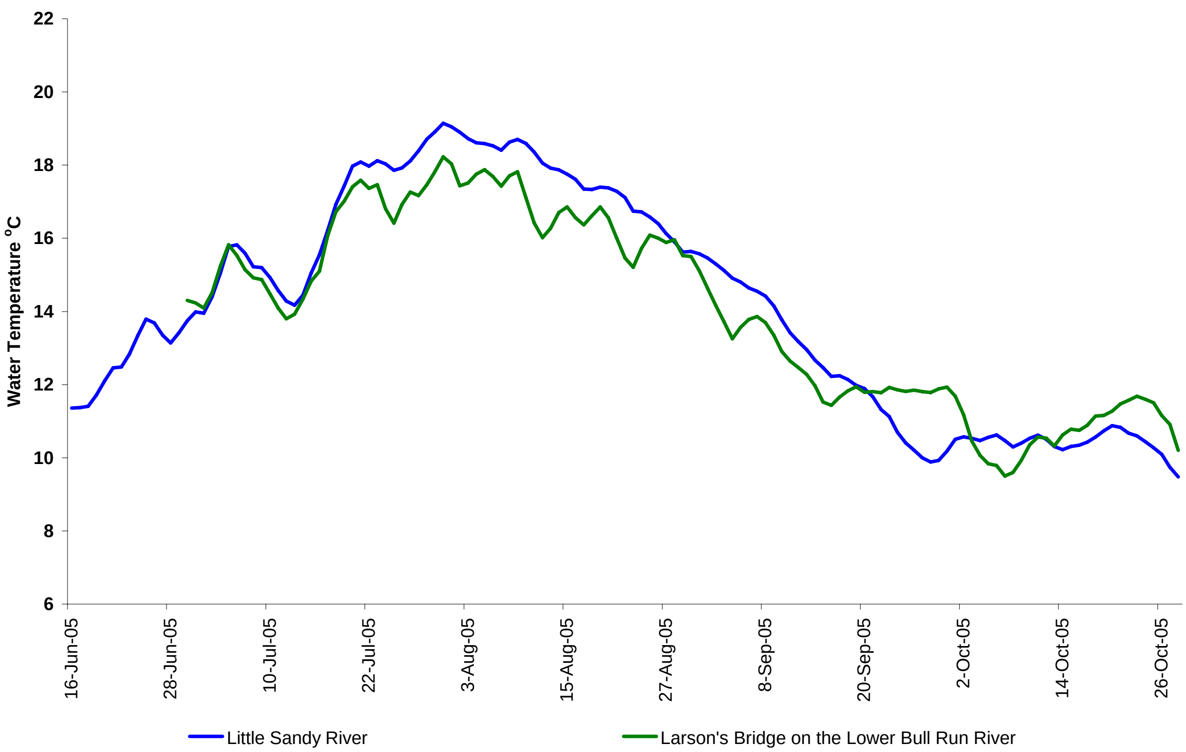


**Figure 8-14. Comparison of Actual 7-Day Maximum Water Temperatures for the Little Sandy with Predicted 7-Day Maximum Average Temperatures Lower Bull Run River, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and CE-QUAL-W2 Modeled Temperatures (February 2006).

The summer and early fall water temperatures in 2005 shows that water temperatures at Larson's Bridge will be generally lower than temperatures in the Little Sandy but are within approximately 1 °C (see Figure 8-14). ODEQ has established water temperature criteria for the Larson's Bridge location under the authority of the CWA and the Sandy Basin TMDL (see Measure T-1 in Chapter 7).

Within five years of the start of the HCP, the infrastructure changes at Dam 2 will be completed and the natural thermal potential of the Bull Run River will be met. Water temperature impacts on steelhead would be minimized.

**Diurnal Water Temperature Fluctuations.** The City anticipates that the diurnal water temperature fluctuations in the lower Bull Run River will be less than what has been observed in recent years. The fluctuations likely to result from implementing the HCP measures were estimated using modeling and measured water temperatures from the lower Bull Run and Little Sandy rivers. Table 8-29 lists observed and expected temperature fluctuations for the summer and late summer months. These are the months when the City's implementation of the water temperature measures (Measures T-1 and T-2) will affect diurnal temperature fluctuations. During other months of the year the diurnal water temperatures fluctuations should not be affected. The fluctuations expected after implementing the HCP measures are predicted to be smaller than the fluctuations that would occur under natural conditions.

**Table 8-29. Diurnal Water Temperature Fluctuations (°C)**

| Month | Bull Run Observed (current conditions) | Little Sandy Observed (natural conditions) | Expected HCP |
|---|---|---|---|
| **June** | 4-6 | 0.5-5 | 2-3 |
| **July** | 4-6 | 1-5 | 2-3 |
| **August** | 3-5 | 1-5 | 2-3 |
| **September** | 2-3 | 1-4 | 1-2 |

Source: Bull Run observed temperatures: USGS Gauge No. 14140000 on the Bull Run River (RM 4.7); Little Sandy observed temperatures: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8); expected HCP temperatures: CE-QUAL-W2 Modeled Temperatures (February 2006).

The City reviewed available research on the influence of fluctuating water temperature on the growth of salmonids. Experiments on steelhead and coho (Hahn 1977; Grabowski 1973; and Thomas et al. 1986) indicated that fluctuating water temperature tests and the constant test exposures produced equivalent results. The City concludes that the reductions in diurnal water temperature fluctuations will not affect winter steelhead or other salmonids that utilize the lower Bull Run River.

### *Large Wood*

Large wood is removed from the upper end of Reservoir 1 to protect the downstream water supply dams from damage. The USFS owns this wood because it is transported by tributaries from national forest land. Since this wood does not travel down the lower Bull Run River, a small amount of beneficial habitat for winter steelhead is potentially lost. The lower Bull Run is, however, a high-order steep stream and is not likely to trap and store large wood. Photographs taken of the lower Bull Run in the late 1890s, before the dams and water diversions were constructed, show little large wood in the channel. The lower river is probably a transport reach for large wood.

The lower Bull Run River is dominated by bedrock and boulders. This channel roughness supports diverse habitats, including about 27 percent pool habitat. The presence of this pool habitat suggests that large wood is not an important requirement of pool formation, and the addition of large wood would provide only a minor increase in pool habitat.

Historically, large wood pieces may have formed some low-velocity areas that juvenile winter steelhead may have utilized during winter months and that helped trap suitable spawning gravel. The City does not believe that the low-velocity areas are important because winter steelhead usually prefer to burrow under substrate during the winter, and the lower Bull Run has suitable substrate for protecting winter steelhead.

The City does not plan to artificially place large wood in the lower Bull Run River above Larson's Bridge because of concerns about the vulnerability of water supply infrastructure (such as conduit trestles). The City will let natural recruitment of large wood occur downstream of Larson's Bridge. Trees that fall naturally will be left in place to modify the stream channel as long as the water conduits and bridges are not threatened. This large wood could slightly improve habitat conditions for winter steelhead by reducing the overall grain sizes and creating pools in localized areas in the lower 3.8 miles of the Bull Run River.

***Spawning Gravel***

The two Bull Run dams interrupt bedload and gravel movement to the lower Bull Run River, resulting in reduced spawning habitat for winter steelhead. The estimated historical gravel supply rate was roughly 30 to 1,000 cubic yards (CH2M HILL 2003b). The City will place approximately 1,200 cubic yards per year for the first five years and 600 cubic yards per year thereafter (see Measure H-1 in Chapter 7). The City will monitor the effects of the gravel placement to determine whether the measure should continue for the term of the HCP or should be modified. The gravel replacement rate will be higher than the estimated natural accumulation. Placement of gravel in the lower Bull Run River should significantly improve the spawning conditions for winter steelhead.

***Access***

Winter steelhead were first blocked from the upper Bull Run watershed in 1921 by construction of the Diversion Dam (approximately RM 5.8). The dam diverted Bull Run water into water conduits to serve the greater Portland metropolitan area. In 1964, as part of the Dam 2 construction, a rock weir was built at RM 5.8 to create the Dam 2 plunge pool for energy dissipation. That structure is now the upstream limit for winter steelhead distribution; however, there are resident populations of rainbow in upstream reservoirs and the upper Bull Run River. The City also blocks approximately 800 feet of Walker Creek, a tributary to the Bull Run River. Historically, this stream was probably used by winter steelhead and rainbow trout.

Winter steelhead access will remain blocked by the rock weir at RM 5.8 during the term of the HCP, preventing access to approximately 34 miles of the upper Bull Run River watershed for winter steelhead that were historically available. Of these blocked miles, 25 miles are free-flowing river; approximately 9 river miles are inundated by City reservoirs. This analysis is conservative and assumes that, historically, winter steelhead were able to migrate upstream of a series of three waterfalls on the mainstream Bull Run River located from RM 16–RM 16.65. The SRBTT concluded that winter steelhead might have been able to ascend the waterfalls under some circumstances, but such occurrences would have been infrequent. Beak (2000c) determined that one waterfall was probably a complete barrier to upstream-migrating winter steelhead. Nevertheless, the City assumed that winter steelhead once consistently passed the waterfalls, and the total river mileages reflect that assumption.

Under this HCP, the City will also open access to Walker Creek, which is a small tributary to the lower Bull Run River. Access to this tributary was probably blocked in the 1960s when the City constructed the Dam 2 facilities. A culvert or other appropriate structure that meets fish passage criteria will be constructed so that winter steelhead have access to approximately 800 feet of Walker Creek.

When PGE removes the Little Sandy Dam, winter steelhead will also have access to an additional 5.6 miles of the mainstem Little Sandy River and 2.0 miles of tributary streams.[9] The City's agreement to maintain flows for fish will help retain habitat benefits from this renewed access to the historical habitat for winter steelhead.

The City will also improve access for steelhead in Alder and Cedar creeks, which are tributaries to the middle Sandy River.  These effects are described below in the Offsite Habitat Effects section.

#### *Riparian Function*

The City owns land along 5.3 miles of the lower Bull Run River (1,650 acres). The City's lands represent 82 percent of the riparian corridor below Dam 2. Managing these lands to protect riparian habitat (see Measure H-2 in Chapter 7) will improve habitat for winter steelhead. Approximately 30 percent of the riparian corridor along the lower river is in late-successional (late-seral) timber that can provide immediate large wood recruitment to the channel. Further, 80 percent of the riparian corridor is of mid- to late-seral age and will provide wood to the channel at an increasing rate over the next 10 to 70 years (Cramer et al. 1997).

Analysis of shading in the lower Bull Run River indicates that riparian vegetation currently intercepts 40 to 60 percent of the total solar radiation that potentially could reach the water surface (Leighton 2002). This shading provides a substantial benefit to maintaining water temperature and will become greater over time as the vegetation continues to mature. Even with mature vegetation in the lower Bull Run, however, water temperatures will not meet ODEQ's numeric water temperature criteria (see temperature effects analysis).

#### *Total Dissolved Gases*

Oregon's Water Quality Standards state that TDG levels should not exceed 110 percent of saturation unless flows exceed the ten-year, seven day average flood (7Q10) flow for the site [OAR 340-041-0031]. The 7Q10 flow for the lower Bull Run River is 5,743 cfs. The City has monitored all water system structures, valves, or turbines that could elevate TDG levels

[9] See Section 4.1.5 Water Quality and Water Rights for more information about the removal of the Little Sandy Dam.

since 2005, and has determined that winter steelhead are unlikely to be adversely affected by TDG levels in the Bull Run River. A 55-feet deep stilling pool at the base of the Dam 2 spillway is the site most likely to produce TDG levels that could affect winter steelhead. This location, however, is upstream of the range of anadromous fish. Monitoring by the City indicates that elevated levels of TDG quickly decrease as water passes over the rock weir below the stilling pool (RM 5.8). The City has never measured TDG levels that met or exceeded 110% in the anadromous portion of the Bull Run River, unless the 7Q10 flow was also exceeded. TDG levels further dissipate downstream of the rock weir. Winter steelhead are probably not impacted by TDG levels in the Bull Run River.The City will continue to monitor TDG levels in the Bull Run, as described in the Effectiveness Monitoring section in Chapter 9 and Appendix F, Monitoring Plans and Protocols.

**Summary of Effects for Winter Steelhead in the Lower Sandy River from Bull Run Measures**

The City identified five types of effects that water supply operations could have on steelhead habitat in the lower Sandy River.

- Base flows in the lower Sandy would be reduced under the HCP by continued water supply operations in the Bull Run, but the weighted usable area for steelhead will not be affected because there is limited spawning in the lower Sandy River.
- Flow downramping effects in the lower Sandy will be avoided because of the City's downramping commitments in the Bull Run HCP.
- The City's HCP measures will probably have small beneficial effects on water temperatures in the lower Sandy.
- The City will also minimize the impact of removing large wood from the lower Bull Run by adding large wood directly into the lower Sandy.

Overall, the City's HCP measures will have positive effects on habitat for winter steelhead in the lower Sandy River.

Table 8-30 summarizes the type of effect, reference conditions, and habitat effects of the HCP conservation measures for winter steelhead in the lower Sandy River.

Table 8-30. Effects of the Bull Run HCP Measures on Lower Sandy River Habitat for Winter Steelhead[a]

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base flows | Natural Sandy River base flows | Flows after implementation of the HCP will be more than 80% of natural base flows.[b] |
| Weighted Usable Area | Natural Sandy River base flows | Flows will increase habitat for spawning by up to 14 percent during January–April and reduce habitat for spawning by 5 percent in May.[c]<br>The City's Bull Run base flows will have minimal negative impact on steelhead spawning in the lower Sandy River because there is limited winter steelhead spawning in the lower Sandy. |
| Flow Downramping | Protective downramping rate: 2"/hour | The City's water supply operations will have minimal effects on fish stranding due to downramping. |
| Water Temperature | ODEQ standard: natural thermal potential | The City's HCP measures will probably have small water temperature benefits. |
| Large Wood | Natural wood routing | City measures will increase large wood levels and habitat diversity, minimizing adverse effects of Bull Run operations in the Sandy River below the Bull Run confluence.<br>Collectively, the City's HCP measures will improve habitat conditions for steelhead/ rainbow trout in the lower Sandy River. |

[a]For the list of conclusions about the habitat effects of all HCP measures on winter steelhead, see page 8-114.
[b]Based on flow data from 1985–2001, natural base flows were reduced by 4–19 percent (CH2M HILL 2002).
[c]Based on flow data from 1985–2001.

### Habitat Effects in the Lower Sandy River from the Bull Run Measures

The EDT database and model were used to identify limiting factors having the greatest effect on winter steelhead in the lower Sandy River below the confluence of the Bull Run River. The factors identified were food, habitat diversity, harvest, flow, channel stability, competition from the same species, predation, water temperature, pathogens, and sediment. Of these 10 factors, three are potentially affected by water supply operations in the Bull Run: streamflow, water temperature, and large wood recruitment (as a subfactor in habitat diversity). The other seven factors are not directly related to water supply operations.

#### *Streamflow*

A flow effects analysis was completed for winter steelhead in the lower Sandy River below the Bull Run (CH2M HILL 2002). This analysis focused on the potential effects of the City's Bull Run operation on base flows and flow fluctuations (ramping). The analysis used Bull Run flows from 1985 to 2001, which are lower than the HCP flows described in Chapter 7.

**Base Flows.** The City compared the WUA and monthly flow amounts without City operations to the WUA and monthly flows during the 1985 to 2001 period. City operations from 1985 to 2001 reduced flows in the lower Sandy River by 4 percent to19 percent (depending on the month), but increased the total available habitat for winter steelhead by 2 percent to 14 percent (depending on the month). During January through April, spawning habitat would be increased by 1.6 percent to 6 percent. In May, the available habitat for winter steelhead spawners would be reduced by 5 percent. These results are conservative because the flows under the HCP are higher than the flows evaluated in the study. The HCP flows should maintain or slightly improve habitat conditions in the lower Sandy River for winter steelhead.

**Downramping.** The CH2M HILL analysis (2002) indicates that the downramping rate of 2"/hour would eliminate juvenile salmonid stranding effects in the lower Sandy River reaches. The downramping measure will prevent any effect on winter steelhead in the lower Sandy River.

#### *Water Temperature*

Both ODEQ's and the City's water temperature modeling results indicate that the lower Sandy River reaches are in a state of relative equilibrium. City water supply operations have little influence on heating or cooling of the lower Sandy River. This conclusion is supported in the Sandy River Basin TMDL (ODEQ 2005).

Even though the City's operations in the Bull Run will not negatively affect water temperatures in the lower Sandy River, some of the City's offsite conservation measures will probably have small water temperature benefits (see discussion for each reach in the subsection "Habitat Effects in the Sandy River Basin from the HCP Offsite Measures" for effects of offsite measures on lower Sandy watershed).

#### *Large Wood*

Removal of large wood from the Bull Run reservoirs reduces the amount of large wood loading to downstream Sandy River reaches and somewhat reduces channel complexity for salmonids. To mitigate for this impact, the HCP includes several large wood measures in the lower Sandy River (see Measures H-4, H-11, H-12, and H-13 in Chapter 7).

### Habitat Effects in the Columbia River from Use of Groundwater

The City will use groundwater from the Columbia South Shore Well Field, in conjunction with the Bull Run River flows, to provide the total amount of water needed to meet water supply demands and the HCP flow commitments. The Columbia River is located adjacent to the well field, so the City analyzed the effect groundwater use might have on flows in the Columbia River.

As context, only one instream flow commitment has been established for the lower Columbia River to maintain the persistence of ESA-listed species. This requirement is the FCRPS's minimum flows of roughly 125,000 cfs below Bonneville Dam, unless competing priorities preclude it (USCOE et. al. 2006). These minimum flows are increased by contributions from the Sandy and Washougal rivers before arriving at the Glenn Jackson Bridge (I-205 bridge), approximately 14 miles west of the mouth of the Sandy River.

The well field has an estimated sustainable capacity of approximately 85 mgd, which is equivalent to approximately 130 cfs. The actual amount and duration of pumping will vary according to the weather and supply conditions, but typically the amount pumped per day would be significantly less than the full capacity. The well field draws on four regional alluvial aquifers. Recharge for these aquifers occurs as far south as the Boring Hills (Hartford and McFarland 1989). These aquifers generally discharge into the Columbia River.

As a simplifying worst-case assumption for this analysis, the City assumed that 85 mgd would be pumped from the well field and that this amount would be drawn into the aquifers from the Columbia River. (This is a significant overestimate because the water pumped would actually be drawn primarily or completely from the aquifers themselves and not from the river into the aquifers.) The assumed flow into the aquifers would reduce the assumed flow available in the Columbia River for fish.

If the City's groundwater pumping were to result in a 130 cfs reduction in Columbia River flows, that reduction would be at most 0. 1 percent of the total river flow (based on the 125,000 cfs minimum flows mentioned above). To put this reduction in perspective, the typical margin of error on measured flows for the Columbia River is +/- 10 percent (see for example the gauge at the Columbia River at The Dalles, USGS 2003). This measurement error is significantly larger than the estimated flow reduction due to groundwater use. In addition, the mainstem Columbia River has tidal fluctuations that average approximately 1.7 feet (data from USGS Gauge No. 14144700). This natural daily change in river stage is many orders of magnitude greater than any potential reduction of Columbia River flows due to the City's use of groundwater. The City's conclusion is therefore that use of the Columbia South Shore Well Field as a means to enable the HCP flow commitments in the lower Bull Run River will have a negligible influence on the Columbia River base flows and associated habitat for winter steelhead migrating in the river.

**Summary of Effects on Winter Steelhead in the Sandy River Basin from the HCP Offsite Measures**

The HCP offsite measures in steelhead production areas are included to mitigate effects that cannot be avoided in the lower Bull Run River.[10] The upper Sandy River, upstream of the Marmot Dam site, has most of the steelhead anchor habitat reaches.

The City will implement measures to benefit winter steelhead in the middle Sandy River watershed, including riparian easements and improvements, large wood placement, and removal of passage barriers on Alder and Cedar creeks. Although the HCP measures in the lower Sandy River were selected with the primary intent to improve habitat conditions for fall Chinook, some benefits will accrue for winter steelhead as well. Overall, the HCP measures planned for the Sandy River Basin will improve channel conditions, increase side channel habitat, and increase large wood loads over time.

- The improvements in the Little Sandy River will increase spawning and rearing habitat and provide cover for juveniles.
- Reduced risk of peak flow displacement, increased cover from predators, reduced impacts from limited food availability, increased rearing and overwintering habitat, and improved habitat diversity will benefit juveniles in the lower and middle Sandy River and Boulder Creek.
- Additional benefits to fish in Boulder Creek include a reduction in fine sediment which will improve habitat for incubating eggs.
- Small temperature benefits will improve parr productivity and egg incubation in the lower and middle Sandy River segments, respectively.
- The improvements in Gordon Creek will provide habitat diversity for rearing juveniles, reduce competition with hatchery fish, and reduce the amount of fine sediment in spawning gravel patches.
- In the upper Sandy River, all juvenile life stages will benefit from the increase in habitat diversity; overwintering juveniles and actively rearing parr will eventually benefit from the large wood loading which will create pool habitat. The one-year carcass placement in the Zigzag River will provide modest food benefits for juveniles as well.

[10] Effects in the lower Bull Run River include reduced base flows and weighted usable areas (WUAs) and blocked access to the upper Bull Run watershed.

- The improvements in the Salmon River will increase key habitat for parr and overwintering juveniles, increase spawning habitat, and provide some small temperature benefits for egg incubation.

- The channel redesign work and riparian easements in the Zigzag River will create additional rearing habitat, and increase habitat diversity for fry. Over time, the riparian easements will also provide small temperature benefits and cover for juveniles. Carcass placement will improve food availability for one year of HCP implementation.

- Passage improvements in Alder and Cedar creeks will add approximately 17 new stream miles for steelhead.

- Measures in Cedar Creek will improve base flows in the summer, increase habitat such as pools and off-channel habitat, and create modest temperature improvements—all benefits for juvenile winter steelhead.

Details of the specific improvements in winter steelhead habitat that will result from the offsite measures are described in this chapter and in Appendix E. Overall, the City's offsite conservation measures will improve habitat for winter steelhead in the Sandy River Basin.

## Habitat Effects in the Sandy River Basin from the HCP Offsite Measures

The City's HCP includes 30 offsite habitat conservation measures. Most of these measures address environmental problems affecting the production of more than one species. This analysis describes the effects of the HCP measures on winter steelhead. Effects are described by watershed, and both life stages and limiting factors are addressed. (See Chapter 5 for additional information on the winter steelhead population in the Sandy River Basin and about the habitat factors limiting production.)

### *Little Sandy River*

The City's water supply operations do not affect the Little Sandy River because it is a tributary to the lower Bull Run River downstream of the City's dams and diversion. The City's large wood habitat conservation measure for the Little Sandy River was selected to improve habitat diversity for spawning and rearing habitat for steelhead and other salmonids.

The City will place large wood in the Little Sandy River (see Measure H-3 in Chapter 7), which will slightly increase channel complexity and gravel sorting for steelhead and other fish species. The City believes that steelhead habitat will benefit slightly from the large wood measure. The large wood will modify the channel hydraulics of the Little Sandy River and trap suitable spawning gravel and will provide more overhead cover for the fish.

### *Lower Sandy River Watershed*

The lower Sandy River watershed consists of the 18.5 miles of the Sandy mainstem between the Bull Run and Columbia river confluences (Sandy 1 and 2 reaches), plus the following tributaries: Beaver, Buck, Gordon, and Trout creeks. Winter steelhead spawn in the tributaries of the lower Sandy watershed, but this may be a result of years of releases from the Sandy Hatchery combined with historical passage difficulties below Marmot Dam. Winter steelhead are believed to spawn in the lower 7.3 miles of Gordon Creek and lower 0.75 mile of Trout Creek, and in lesser numbers in the lower half-mile of Buck Creek and the lower 7 miles of Beaver Creek. In the mainstem Sandy River, the majority of winter steelhead spawning occurs in reach Sandy 2, between Dabney Park and the Bull Run confluence.

HCP measures were selected in the lower Sandy River with the primary intent to improve habitat conditions for fall Chinook. However, the measures in the lower Sandy will also mitigate effects on rearing winter steelhead that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The City also considered the habitat factors that are limiting productivity of winter steelhead in the lower Sandy River. The analysis considers beneficial effects for winter steelhead likely to result from measures designed primarily for fall Chinook.

The City will implement measures, including a reconnected side channel, reestablished mouth, riparian restoration, and engineered log jams on the lower Sandy mainstem, as well as large wood placement and riparian enhancements in Gordon and Trout creeks. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

Table 8-31 lists the reaches affected by HCP measures planned in the lower Sandy River and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-31. Habitat Benefits for Winter Steelhead in the Lower Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Beaver 1A | Riparian function | Improvement |
| | Large wood | Increase |
| Gordon 1A | Fine sediment in gravel patches | Decrease |
| | Backwater pools | Increase |
| | Large-cobble riffles | Decrease |
| | Pool habitat | Increase |
| | Pool-tail habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Gordon 1B | Backwater pools | Increase |
| | Pool habitat | Increase |
| | Pool-tail habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 1 | Artificial confinement | Reduction |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 2 | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Trout 1A | Large wood | Increase |
| Trout 2A | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

The riparian protection/enhancement projects in the lower Sandy mainstem reaches will increase large wood, improve riparian function, decrease confinement in Sandy 1, and improve temperature. A major impact of these measures is the very large increase in the amount of rearing and overwintering habitat provided by the reconnected side channels. Side-channel reconnection is also likely to aid adult passage.

The slow pools in the restored side channels will increase key habitat in Sandy 1 for overwintering juveniles. The combined effect of improved riparian function and increased large wood should significantly improve habitat diversity for parr. Additional large wood will help stabilize the stream channel, lessen peak flow displacement risks to overwintering juveniles, and provide escape cover from predators. Improved riparian function will somewhat reduce temperature impacts, thereby improving parr productivity. Increased riparian function should also lessen impacts attributed to limited food availability and competition with hatchery fish.

Key habitat for juveniles will dramatically increase in Gordon Creek due to the additional pools, backwater pools, and pool tail-outs. This additional rearing habitat should reduce the effects of competition with hatchery fish. The large wood will also increase habitat diversity for parr and overwintering juveniles. Gravel retention by the 300 newly installed log structures will improve channel stability. The riparian enhancement project on the lowermost reach will stabilize crumbling banks and filter out surface inputs of sediment to spawning substrate.

Large wood measures in Trout Creek will directly increase the stability of gravel bars, thus aiding incubation and overwintering.

#### *Middle Sandy River Watershed*

Most of the Middle Sandy mainstem is carved through bedrock in a deep, steep-walled gorge. Winter steelhead primarily use this river segment as a migration corridor (SRBP 2005). The main impact to habitat quality in the mainstem middle Sandy has been Marmot Dam, which was decommissioned in July 2007.

Upstream of the Marmot Dam site, little spawning has occurred in the middle Sandy, except in the inflow reach of the Marmot Dam site. This reach (Sandy 6) provides exceptional mainstem spawning and rearing habitat with a low gradient, pools, riffles, side channels, and relatively abundant cobble/gravel substrate and large wood.

The portions of Alder and Cedar creeks that are accessible to winter steelhead support natural productivity. A weir constructed in the early 1950s partially blocks fish passage approximately 0.5 mile upstream from the mouth of Cedar Creek (SRBP 2005).

The HCP measures for winter steelhead production areas in the middle Sandy River were selected with the intent to mitigate effects that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The City also considered the habitat factors that are limiting productivity of winter steelhead in the middle Sandy River. In addition, the analysis considers beneficial effects for winter steelhead that are likely to result from measures designed primarily for other species.

The City will implement measures to benefit winter steelhead in the Middle Sandy River watershed, including riparian easements and improvements, carcass placement, large wood placement, removal of a passage barrier, and water rights purchases. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

The City will also modify structures in Cedar and Alder creeks, which are important tributaries to the middle Sandy River. After the modifications are made, approximately 5.5 river miles will be accessible for steelhead in Alder Creek, and approximately 12 miles will be opened for steelhead in Cedar Creek.

Table 8-32 lists the reaches affected by HCP measures planned in the middle Sandy River, and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-32. Habitat Benefits for Winter Steelhead in the Middle Sandy River Watershed, by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Alder 1 | Large wood | Increase |
| | Blocked access | Increase |
| Alder 1A | Riparian function | Improvement |
| | Blocked access | Increase |
| | Large wood | Increase |
| Alder 2 | Riparian function | Improvement |
| | Large wood | Increase |
| Cedar 1 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Minimum water temperature | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| | Blocked access | Increase |
| Cedar 2 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Minimum water temperature | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| | Large wood | Increase |
| Cedar 3 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Beaver pond habitat | Increase |
| | Off-channel habitat | Increase |
| | Pool habitat | Increase |
| | Riparian function | Improvement |
| | Minimum water temperature score | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| | Large wood | Increase |
| | Maximum water temperature | Decrease |

Table continued on next page

**Table 8-32. Habitat Benefits for Winter Steelhead in the Middle Sandy River Watershed, by Reach, continued**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Sandy 3 | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 7 | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

Riparian easements and improvements in the Sandy River and in Alder and Cedar creeks will protect intact portions of riparian corridor, improve the species composition (by culling hardwoods and planting conifers), and allow for related habitat improvements (such as large wood recruitment and decrease in temperature) to occur over time. Large wood placement will increase channel stability for all life stages, decrease the risk of juvenile displacement by peak flows, and improve habitat diversity. The modest improvement in temperature will improve incubation slightly. Salmon carcasses placed in the Salmon River will improve food availability for juveniles.

Modifying the fish passage barriers on Alder Creek will open up approximately five new stream miles for winter steelhead use.

Purchasing water rights on Cedar Creek will increase summer base flows for rearing. Rearing juveniles may also benefit from lower water temperatures after the fish passage is provided past the ODFW hatchery weir. The benefits from the water rights purchase are not represented in Table 8-32 because the effects were not calculated in the EDT model.

### *Upper Sandy River Watershed*

Most of the upper Sandy River watershed is located in the Mt. Hood Wilderness and receives little anthropogenic disturbance. With the exception of the lowermost reach (Sandy 8), winter steelhead production is limited by naturally occurring conditions. Sandy 8 has been straightened, cleaned of large wood and large boulders, and confined between riprapped banks in response to the 1964 flood and due to development that has occurred between the communities of Zigzag and Brightwood.

The HCP measure in the upper Sandy River was selected with the intent to mitigate effects on rearing winter steelhead that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The City also considered the habitat factors that are limiting productivity of winter steelhead in the upper Sandy River.

The City will implement one measure in reach 8 of the upper Sandy River to benefit winter steelhead, a riparian easement. A detailed description of the measure and the affected reaches, by watershed, is presented in Chapter 7.

Table 8-33 lists the reach affected in the upper Sandy River and the expected habitat benefits (Tables in Appendix E show percentages for the reference and post-implementation conditions).

**Table 8-33. Habitat Benefits for Winter Steelhead in the Upper Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Sandy 8 | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

Improvement in riparian function and large wood will increase habitat diversity for all juvenile life stages and will reduce channel instability, thus improving the survival of overwintering juveniles. The least productive winter steelhead life stages in the lowermost reach of the upper Sandy River are actively rearing parr and overwintering juveniles. Both juvenile life stages are mainly affected by a lack of key habitat, particularly pools; both also suffer lesser impacts from a lack of habitat diversity and flow. The increase in large wood loading will eventually result in increased pool area, thereby creating key habitat for parr and overwintering juveniles. The improved riparian function and the carcasses that wash out of the Zigzag River into this reach will boost food production for all juveniles, but the carcass placement is only planned for a single year.

### *Salmon River Watershed*

Winter steelhead spawn in the lower 13.2 miles of the Salmon River (reaches 1–3) and in the tributaries entering these reaches, including 4.4 miles of Boulder Creek. These reaches are clearwater streams that are important to steelhead for rearing.

The HCP measures were selected in winter steelhead production areas with the intent to mitigate effects that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The City also considered the habitat factors that are limiting productivity of winter steelhead in the Salmon River and its major tributary, Boulder Creek. In addition, the analysis considers beneficial effects for winter steelhead that are likely to result from measures designed primarily for other species. The City will implement measures in the Salmon River watershed to benefit winter steelhead, including purchasing riparian easements, acquiring and restoring the Miller Quarry property, adding large wood to Boulder Creek, and adding salmon carcasses. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

Table 8-34 lists the reaches affected by HCP measures planned in the Salmon River and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-34. Habitat Benefits for Winter Steelhead in the Salmon River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Boulder 0 | Fine sediments by surface area | Decrease |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Boulder 1 | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 1 | Off-channel habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 2 | Average depth of bed scour | Reduction |
| | Artificial confinement | Reduction |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 3 | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

The measures affecting the Salmon River reach significantly increase the amount and diversity of habitat for winter steelhead, particularly for parr and overwintering juveniles. These increases occur primarily as a result of increased large wood and increased off-channel habitat. Egg incubation is also benefited by increased spawning habitat (e.g., small cobble riffles), improved water temperatures, and increased channel stability.

Measures in Boulder Creek will dramatically increase large wood, which will improve habitat for winter steelhead fry. The measures will also create a small improvement in fine sediment which is a key limiting factor for steelhead incubation in lower Boulder Creek. Temperature improvements will propagate to some degree downstream to the lower Salmon River, where temperature is a continuing problem, especially for rearing fish in the lower Salmon River.

***Zigzag River Watershed***

Most of the Zigzag River watershed supporting winter steelhead consists of three reaches making up 9.4 miles of the lower mainstem Zigzag River (Zigzag 1A, 1B, and 1C), 9.4 miles of lower Still Creek, and 4.0 miles of lower Camp Creek.

The lower Zigzag River mainstem has been damaged by floods occurring in 1964 and 1972 and by the flood control projects implemented afterwards. Although the floods scoured the channel and swept large wood downstream, the flood control measures removed the remaining large logs and boulders and deepened and straightened the cleaned channel, thereby cutting off meanders, oxbows, and side channels. In contrast, Still Creek and Camp Creek are providing high quality spawning and rearing habitat for salmon and winter steelhead (SRBP 2005).

HCP measures were selected in the Zigzag River with the intent to mitigate effects on rearing winter steelhead that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The City also considered the habitat factors that are limiting productivity of winter steelhead in the Zigzag River.

The City will implement measures in the Zigzag River to benefit winter steelhead, including reconstructing natural channel, purchasing riparian easements, and placing salmon carcasses. A detailed description of each measure and the affected reaches is available, by watershed, in Chapter 7.

Table 8-35 lists the reaches affected by HCP measures planned in the Zigzag River and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-35. Habitat Benefits for Winter Steelhead in the Zigzag River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Zigzag 1A | Artificial confinement | Reduction |
| | Harassment | Improvement |
| | Large-cobble riffles | Decrease |
| | Small-cobble riffles | Increase |
| | Pools | Increase |
| | Pool-tails | Increase |
| | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a,b] |
| | Large wood | Increase |
| Zigzag 1B | Carcasses per stream mile | Increase[a] |
| Zigzag 1C | Carcasses per stream mile | Increase[a,b] |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

The lower Zigzag channel reconstruction project will essentially restore the stream channel and floodplain to pre-1964 conditions. Resloped stream banks will reduce bank failure; floodplain connectivity and hydraulic connections between the main channel and disconnected oxbows and side channels will be reestablished; a natural meander amplitude and frequency will be restored to the channel; and instream structures will retain gravel. These actions will greatly reduce the degree to which winter steelhead eggs are lost due to bedload movement and will also create additional small gravel riffles and pool tail-outs for spawners.

The “remeandering” of the main channel will reduce stream gradient, thereby reducing water velocity, increasing habitat diversity for fry, and further reducing egg loss due to channel instability. The increased bends and reduced water velocities associated with remeandering will also transform the lower mainstem from a transport reach to a retention reach for large wood, thus increasing habitat diversity for juveniles, creating and stabilizing gravel bars, and scouring new pools. The general reduction of water velocity and bedload movement associated with channel restoration should allow for deposition of gravel-sized particles, thereby transforming large substrate “pocket water” riffles to small cobble/gravel spawning riffles. Reconnecting oxbows and side channels to the main river will provide badly needed habitat diversity and nursery habitat for fry.

The riparian easements and enhancements will protect intact portions of the riparian corridor and will improve riparian function by culling hardwoods and planting conifers. Over time, habitat conditions related to riparian vegetation (habitat diversity, large wood recruitment, security cover, and temperature) will improve.

**Summary of Population Effects and VSP Parameters**

The VSP parameters for productivity, diversity, and abundance for the Sandy River population of winter steelhead are projected to increase by 6–8 percent under the HCP.* The projected increases in the VSP parameters should also be considered as modest projections because they do not include any potential benefits to steelhead that may be derived from projects supported by the City's $9 million Habitat Fund (see Measure H–30, Chapter 7).

* If Cedar Creek weir removal is included, the VSP parameters are expected to increase by 7–15 percent.

### Population Effects and VSP Parameters

The HCP habitat measures were designed to mitigate the effects of the Bull Run water supply on winter steelhead and other covered species. This section describes the estimated effects of the City's HCP on the overall Sandy River winter steelhead population using parameters established in the NMFS recovery planning process, specifically the work of the LCR-TRT.

Sandy River winter steelhead are part of the Lower Columbia River Distinct Population Segment (DPS); the population is considered by the LCR-TRT and the LCRFRB (LCRFRB 2004) to be a primary population for recovery in the Lower Columbia ESU. Primary populations are those that the TRT believes needs to be restored to "High" or "Very High" viability levels in order to recover the species. Winter steelhead have been identified as needing to be restored to a "High" viability level, or a 95–99 percent likelihood of persistence (LCRFRB 2004).

The EDT model was used to estimate the benefits for winter steelhead that are likely to result from implementing the HCP. Although the model results are not absolute predictions of fish abundance, they do provide a relative comparison of the expected salmon population performance based on the best available science. The inputs to the model represent a combination of site-specific empirical habitat data and, when data were not available, the professional opinion of biologists intimately familiar with the Sandy River ecosystem.

The HCP measures are expected to result in substantial increases in all of the Sandy River winter steelhead VSP parameters. Increases in productivity, diversity, and abundance for winter steelhead are presented in Table 8-36. These estimates represent increases over what could be expected to result from current habitat conditions in the Sandy River Basin. Improvements in spatial structure are discussed in the Spatial Structure subsection on the next page. NMFS (in coordination with ODFW) has not yet developed a recovery plan for the Lower Columbia ESU nor set clear objectives for each VSP parameter; therefore, the significance of these improvements is not yet known.

**Table 8-36. Increases for Winter Steelhead Expected Due to HCP Implementation[a]**

| | Productivity | Diversity | Abundance |
|---|---|---|---|
| **Without Cedar Creek Weir Removal** | 7% | 6% | 8% |
| **With Cedar Creek Weir Removal** | 7% | 15% | 12% |

Source: EDT model run April 17, 2007
[a]Estimates do not include benefits from removing the Marmot Dam on the Sandy River.

### *Productivity*

The estimated 7 percent increase in productivity results from an increase in the quality of stream habitat located primarily in the Zigzag and Salmon rivers and the Sandy River mainstem. Smaller benefits accrue to winter steelhead in Boulder and Alder creeks. Protecting instream water rights for fish in Cedar Creek will also prevent a loss in overall population productivity. The 7 percent improvement in productivity increases population resilience to habitat degradation, thereby reducing population extinction risk.

### *Diversity*

The estimated 6 percent to 15 percent increase in diversity represents improvements in habitat conditions over time and space. Most of these improvements occur in the Zigzag River, Gordon Creek, lower Bull Run River, and lower Sandy River.

### *Abundance*

The estimated 8 percent to 12 percent improvement in winter steelhead abundance results from the increases in productivity and diversity. Increased abundance reduces extinction risk for the population. Higher abundance also results in increased ecological benefits. Salmonids improve both their physical and biological environments through various mechanisms. For example, adult spawners reduce fine sediment concentrations in gravels and their carcasses provide a food source for other aquatic and terrestrial species.

The LCR-TRT defines viability for Sandy River winter steelhead as 1,800 adults produced from the Sandy River Basin (McElhany et al. 2003). The City's HCP measures make a significant contribution toward achieving this objective (see the Population Effects subsection below for a population benchmark comparison).

### *Spatial Structure*

The viability of a salmon population depends not only on the population's productivity, abundance, and diversity, but also on its spatial structure (McElhany et al. 2000). The more watersheds in a basin that contain large numbers of spawners, the less likely that catastrophic events such as landslides or human-caused disasters will result in the extinction of the population.

Winter steelhead currently spawn in all of the Sandy Basin watersheds to some degree, but tend to use the Sandy River above the former Marmot Dam site, the Salmon River watershed, and Still Creek most heavily. Spawning winter steelhead have also been found in the Sandy River downstream of the Marmot Dam site, the lower Bull Run River, and many of the middle and lower Sandy River tributaries, including Gordon, Trout, Cedar, and Alder creeks. Since 1998, the watershed above the Marmot Dam site has become a wild winter steelhead sanctuary. Historically, winter steelhead spawning and rearing was widely distributed throughout the Basin.

The HCP actions will increase steelhead distribution in Alder and Cedar creeks. About 18 river miles will be opened for steelhead usage.  That is approximately an 11 percent increase in the current steelhead distribution for the Sandy River Basin.

The HCP improves spatial structure because actions are focused on increasing spawner access and abundance in all of the five watersheds that supported winter steelhead production historically. Increased adult abundance in multiple watersheds reduces population exposure to catastrophic events, and thus reduces extinction risk.

Table 8-37 summarizes the population effects of the HCP measures on steelhead by the VSP parameters of abundance, productivity, diversity, and spatial structure.

**Table 8-37. Effects of the HCP Measures on Sandy River Basin Winter Steelhead by Viable Salmonid Population (VSP) Parameters**

| VSP Parameter | Reference Condition | Effect of Conservation Measures |
|---|---|---|
| **Abundance** | Current habitat conditions | Winter steelhead abundance for the Sandy River population is projected to increase by 8-12%. |
| **Productivity** | Current habitat conditions | Productivity for the Sandy River winter steelhead population is projected to increase by 7%. |
| **Diversity** | Current habitat conditions | Diversity for the Sandy River population is projected to increase by 6-15%. |
| **Spatial Structure** | Current habitat conditions | Spatial structure improves as actions are focused on increasing spawner abundance in five of the five watersheds that supported winter steelhead production historically. Increased adult abundance in multiple watersheds reduces population exposure to catastrophic events, and thus reduces extinction risk. |

Sources: EDT model run April 17, 2007 for abundance, productivity, and diversity percentages; for spatial structure assessment, Kevin Malone, personal comm. 2006

**Summary Comparison of Fish Abundance**

The projection of adult steelhead abundance under the City's HCP is comparable, albeit somewhat lower, to the benchmark comparison scenario established for the Bull Run watershed. The projected increases in abundance should also be considered as a modest projection because it does not include any potential benefits to steelhead that may be derived from projects supported by the City's $9 million Habitat Fund (see Measure H-30, Chapter 7). This benchmark comparison indicates that the HCP will produce enough beneficial habitat changes for steelhead to offset all potential impacts that could be caused by the City's water supply operations in the Bull Run.

## Population Effects and Benchmark Comparison of Fish Abundance

The introduction to this HCP chapter describes a benchmark scenario the City developed to compare results of the HCP measures with production potential of the Bull Run watershed (see Section 8.1.1). The EDT model was used to generate the estimated abundance of winter steelhead and to compare the benchmark against the benefits of the City's HCP measures. The City believes that the Modified Historical Bull Run Condition benchmark estimate represents generous assumptions and the HCP estimate is an underestimate of probable HCP results (see Section 8.1.1).

Model results indicate that the HCP measures would improve habitat sufficiently to approximately match the production potential of the Modified Historical Bull Run Condition (Table 8-38).

**Table 8-38. Model Results for Winter Steelhead Abundance: Modified Historical Bull Run Condition Compared with HCP Measure Implementation[a]**

| Scenario | Adult Abundance |
|---|---|
| Modified Historical Bull Run Condition | 3,880 |
| HCP Measures Without Cedar Creek | 3,575 |
| HCP Measures With Cedar Creek | 3,701 |

Source: EDT model run April 17, 2007
[a]Estimates do not include benefits from removing the Marmot Dam on the Sandy River.

The City believes these results help demonstrate that the HCP will provide the benefits for winter steelhead necessary to meet the ESA Section 10 requirements. However, the City does not propose to use EDT population estimates as an enforceable performance measure for winter steelhead. The City's HCP is purposefully habitat based. It is designed using measurable objectives, monitoring, and an adaptive management trigger that all relate to habitat condition, as described in other chapters of this document.

### Conclusions about the Habitat Effects of HCP Measure Implementation

- **Effects in the Lower Bull Run River.** All of the HCP measures in the lower Bull Run River will benefit steelhead. These measures avoid or minimize ongoing City impacts in the Bull Run River (as described in Table 7-1) to the maximum extent practicable. Impacts associated with blocked fish access to the upper watershed and reduced base flows will not be completely addressed in the Bull Run but will be mitigated by offsite measures in the Sandy Basin. Benefits provided by the Bull Run HCP measures are summarized in Table 8-26.
- **Effects in the Sandy River Watersheds.** Substantial additional benefits for steelhead are provided by HCP measures in the upper Sandy River and its tributaries (e.g., Salmon and Zigzag rivers), the middle Sandy Basin, and the lower Sandy River Basin. The upper Sandy has the primary spawning areas for steelhead and most anchor habitat reaches for steelhead are upstream of the Marmot Dam site. The primary limiting factor for steelhead for that area is reduced habitat diversity. HCP measure H-18 will improve conditions for steelhead on the mainstem Sandy River and Measures H-19, H-20, H-21, H-22, H-23, H-24, H-27, H-28, and H-29 will improve habitat in important tributary streams like the Salmon and Zigzag rivers. For the middle Sandy Basin, Measures H-14, H-15, H-16, and H-17 will improve large wood levels, riparian zone conditions, and channel diversity for steelhead in the mainstem Sandy River and Cedar Creek. The HCP measures will also open new habitat for steelhead in Alder and Cedar creeks. HCP measures in the lower mainstem Sandy (H-11, H-12) will slightly improve habitat for migrating steelhead juveniles, and measures H-5, H-6, H-7, and H-13 will improve rearing habitat in lower Sandy tributaries. Benefits provided by the offsite measures are summarized in Tables 8-31 and 8-35 and in Appendix E, Tables E-5 and E-6.
- **Timing for Implementing Measures.** The timing for implementing measures relevant to winter steelhead and other species is provided in Tables 7-6 through 7-12. Measures in the upper Sandy River are primarily scheduled for HCP Years 11-15, with some of them in Years 6-10. Most of the measures for steelhead in the middle Sandy Basin will occur in HCP Years 6-10. The lower Sandy tributary actions and mainstem Sandy easement measures for steelhead will be done in HCP Years 1-5. The City will be conducting effectiveness monitoring for the instream measures; the objective in those cases is to accrue 80 percent of the predicted habitat change within 15 years of implementing each measure (see Chapter 9).
- **Population Response.** Although the HCP is not intended to guarantee specific population responses, implementation of the HCP is expected to result in improved population conditions for steelhead. Table 8-37 describes the anticipated increases of the four VSP parameters: abundance, productivity, diversity, and spatial structure. The estimated population response compared to the Modified Historical Bull Run Condition also indicates that implementation of the HCP will likely result in a population response that is approximately the same as the production potential in the Bull Run watershed. Neither of these estimates includes the habitat or population benefits that will result from the $9 million Habitat Fund.

- **Accumulation of Habitat Benefits.** The HCP conservation measures will accumulate benefits for steelhead at varying rates. Figure 8-15, based on EDT model results, depicts the accumulation of benefits over the 50-year HCP term. The figure shows the predicted increase in adult steelhead abundance that could result from the habitat changes. Benefits are organized according to four general categories of HCP measures: flow, fish passage improvements, instream actions, and riparian easements. The City assumes that the benefits from large wood additions would only contribute to adult steelhead abundance for the first 15 years of their project life. This is a very conservative assumption because it is likely that the wood will be in the various stream reaches beyond 15 years and adding some habitat value for fish. Other instream actions, such as the opening of side channels and riprap removal, are considered permanent for the purpose of the HCP. Riparian easements are assumed to take 15 years before beginning to provide benefits and would not provide full benefits until 30 years after implementation. Flow measures will provide habitat for steelhead starting in Year 1 of the HCP, and fish passage improvements for Cedar Creek should start benefiting steelhead in approximately Year 6 This analysis does not include benefits from providing fish passage in Alder Creek.

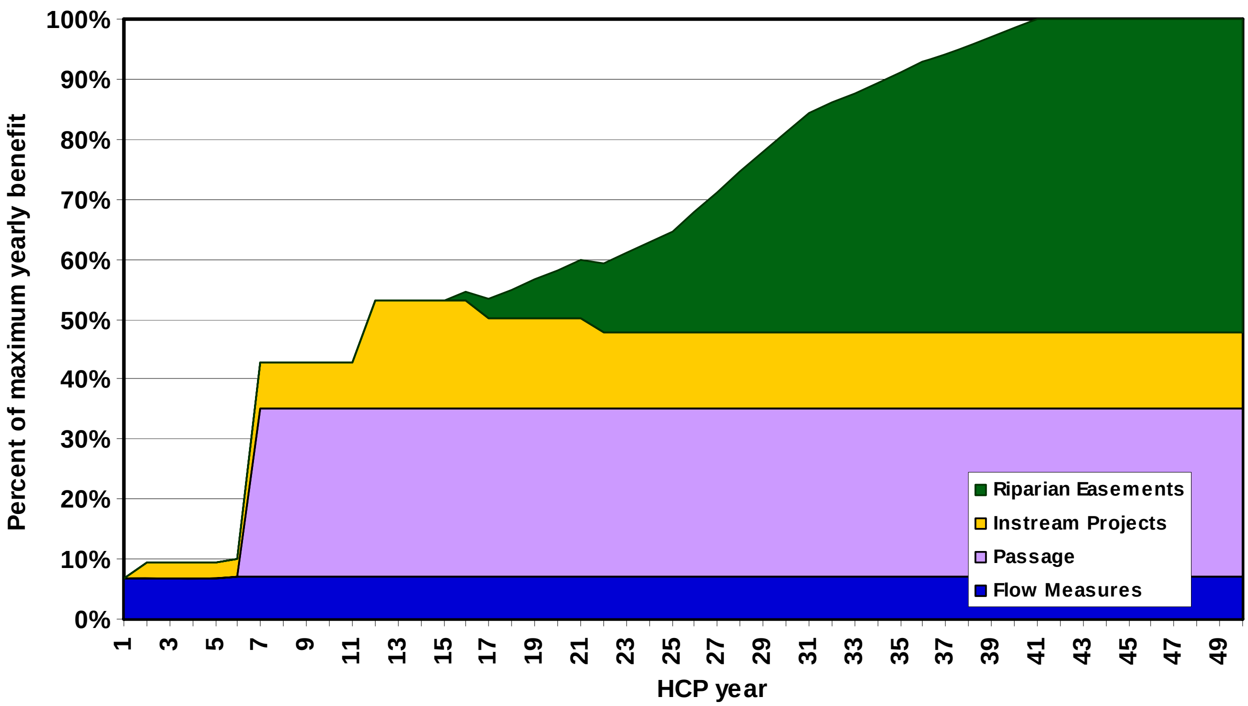


**Figure 8-15. Accumulation of Predicted Benefits to Winter Steelhead from HCP Measures over Time[a]**

Source: EDT model runs, April 10, 2007.

[a]The accumulated benefits exclude benefits from the following measures: H-3—Little Sandy 1 and 2 LW Placement, P-2—Alder 1 Fish Passage, P-3—Alder 1A Fish Passage, H-25—Salmon 2 Carcass Placement, H-29—Zigzag 1A, 1B, and 1C Carcass Placement

The full steelhead benefits would be realized by approximately HCP year 40. This maximum benefit level closely corresponds to the abundance number used in Table 8-38 for the "HCP Measures with Cedar Creek" scenario, but the benefit level excludes the benefits of large wood additions. Through the term of the HCP, the cumulative total benefits will be 11 percent from the flow measures, 17 percent from instream measures, 35 percent from riparian easements, and 37 percent from the Cedar Creek fish passage improvements.

**The City believes the HCP, as a whole, meets ESA Section 10 requirements for steelhead.**

### 8.2.4 Coho Habitat Effects

The HCP measures in the Bull Run watershed minimize the effects on juvenile and adult coho salmon in the lower Bull Run River to the maximum extent practicable. Offsite measures were selected to provide additional benefits for coho salmon to help mitigate for the effects not avoided in the Bull Run. In addition, offsite measures that mitigate for impacts on other covered species also provide benefits for coho. Chapter 11 describes the city's commitment to fund the implementation of the necessary measures.

The potential effects of the City's Bull Run water supply operations on coho salmon in the Sandy River Basin are described in this section. These effects are described in six subsections:

1. Effects in the lower Bull Run River—Describes the habitat effects of both the City's water supply operations and the HCP measures on lower Bull Run habitat for coho
2. Effects in the lower Sandy River— Describes the habitat effects of both the City's water supply operations and the HCP measures on habitat for coho in the lower Sandy River
3. Effects in the Columbia River— Describes the effects of using the City's groundwater supply at the Columbia South Shore Well Field on fish habitat in the Columbia River
4. Effects in Sandy River Basin watersheds—Describes the habitat effects of the offsite HCP measures on coho habitat in watersheds of the Sandy River Basin
5. Effects on the Sandy River populations, by VSP parameter—Describes the population effects of all of the HCP measures (those in the Bull Run and those in the Sandy River Basin offsite locations) on abundance, productivity, diversity, and spatial structure for coho
6. Comparison to a population benchmark—Compares estimates of coho abundance to under historical conditions to estimated abundance after HCP implementation

Summaries for all subsections appear in gray shaded boxes. A detailed description of the effects for the species in the geographic location follows each summary. Conclusions about the habitat effects on coho from implementation of all HCP measures, including the predicted accumulation of habitat benefits over time, are provided on page 8-151.

**Summary of Effects on Coho Salmon in the Bull Run Watershed from Bull Run Water Supply Operations and HCP Measures**

The City identified 10 types of effects that the HCP conservation measures will have on coho in the Bull Run watershed. The City also analyzed the potential impacts on the base flow of the Columbia River from the HCP flow commitments.

- Impacts associated with fish access to the upper Bull Run watershed, low base flows, and low weighted usable areas will be reduced with the Bull Run conservation measures, but not all impacts will be avoided. Impacts that are unavoidable will be offset by the Sandy offsite conservation measures.
- The Little Sandy flow commitment will increase habitat for coho for the term of the HCP.
- Impacts on spawning gravel, flow downramping, and riparian function will be avoided by the measures.
- There will be some short-term negative water temperature impacts, but long term, the natural thermal potential of the lower river will be returned by the City's infrastructure and operational changes for its dams and reservoirs.
- The removal of large wood at the reservoirs is considered a small impact on coho, and that effect will be mitigated by large wood placements in other streams of the Sandy River Basin that are prime coho production areas.
- The City does not know whether TDG levels harm coho in the lower Bull Run, but they will be studied under this HCP and addressed through adaptive management provisions described in Chapter 9.
- The City's flow measures will have an extremely small effect on the Columbia River base flows, and coho habitat will not be affected.

Table 8-39 summarizes the effects of the water supply operations, the reference condition for the effect, and the predicted effects of the City's HCP conservation measures in the Bull Run watershed for coho.

**Table 8-39. Effects of the Bull Run Measures on Lower Bull Run River Habitat for Coho Salmon[a]**

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base flows<br>Winter/Spring Period (egg incubation and juvenile rearing)<br>Summer Period (juvenile rearing)<br>Fall Period (spawning) | Natural Bull Run base flows | Projected HCP flows will be 77 to 81% of natural base flows during the egg incubation and juvenile rearing period from January to May.<br>Projected HCP flows will be 36 to 46% of the natural base flows from June to September for juvenile rearing.<br>Projected HCP flows will be 50 to 80% of natural base flows during the spawning period (October to December). |
| Weighted Useable Area (WUA)<br>Winter/Spring Period (juvenile rearing)<br>Summer Period (juvenile rearing)<br>Fall Period (spawning) | Natural flow<br>Weighted Usable Area | HCP WUAs for juvenile rearing from January to May will be close to 100% of the maximum WUA value. All impacts will be avoided. HCP WUAs for juvenile rearing from June to September will be 70 to 100% of natural flow WUA levels.<br>HCP WUAs for spawning will be 75 to 100% of the natural flow WUA levels. |
| Flow Downramping | Protective downramping rate: 2”/hour | The City will meet the protective downramping rate (2”/hour), and fish stranding effects will be minimal. |
| Little Sandy Base flows | Natural flow; free-flowing | City measures will ensure access to approximately 10 new miles of stream habitat in the Little Sandy River. |
| Water Temperature | ODEQ standard: natural thermal potential | There will be minor, short-term water temperature impacts prior to installation of infrastructure improvements at Dam 1. Once the infrastructure improvements are in place, all water temperature impacts in the lower Bull Run River will be avoided. |

**Table 8-39. Effects of the Bull Run Measures on Lower Bull Run River Habitat for Coho Salmon,[a] continued**

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Large Wood | Natural wood routing and accumulation | The natural accumulation of wood downstream of Larson's Bridge will slightly improve pool formation, gravel recruitment, and the creation of low-velocity habitat. |
| Spawning Gravel | Natural levels of gravel recruitment | The City will replace the natural level of gravel recruitment in the lower Bull Run River. All impacts will be minimized. |
| Fish Access | Historical fish anadromy<br>Total blocked stream miles in the Bull Run River watershed: 26.9<br>Blocked free-flowing miles in the Bull Run River watershed (excluding the Little Sandy River): 12.1 | City will not provide access into the upper Bull Run River.<br>Approximately 10 miles of river will be provided in the Little Sandy River, of which 8 miles could be used by coho. |
| Riparian Function | Mature riparian zones | City's riparian lands along the lower Bull Run River are currently in good condition. Protective measures in the HCP will maintain and somewhat improve these conditions as younger trees mature. |
| Total Dissolved Gases (TDG) | ODEQ standard. Maximum of 110% saturation at flows below the 7Q10 flow | The City does not believe there are elevated TDG levels in the current range of anadromy at flows below the 7Q10 flow, but the City will continue monitoring to determine whether the ODEQ standard is being met. |

[a]For the list of conclusions about the habitat effects of all HCP measures on coho, see page 8-151.

### Habitat Effects in the Bull Run Watershed for Coho

The effects on coho salmon in the lower Bull Run River are described in the following categories: streamflow, water temperature, large wood, spawning gravel, access, riparian function, and TDG.

#### *Streamflow*

The City analyzed streamflow effects on coho salmon by two means: comparing the effects of the HCP Bull Run base flows with the natural (pre-water-system) conditions and by determining the coho spawning and rearing WUA likely to result from Bull Run flow measures.

**Bull Run Base Flows.** The City compared an estimate of median monthly flows (50 percent exceedance flows) under natural conditions (i.e., no dams or diversions in the Bull Run watershed) with anticipated future flows during implementation of the HCP, assuming normal and critical years occur at the same frequency in the Bull Run as they have in the past. A 64-year hydrological record (1940–2004) was used for the analysis. The estimated median flows are for the Bull Run River upstream of the Little Sandy River are shown in Figure 8-14; all flow amounts are relative to the USGS Gauge No. 14140000 located at RM 4.7 on the Bull Run River. The flow analysis considers coho salmon utilization of habitat in the lower Bull Run River, as shown in the periodicity chart in Chapter 5 (Figure 5-36) and Figure 8-16 on the next page.

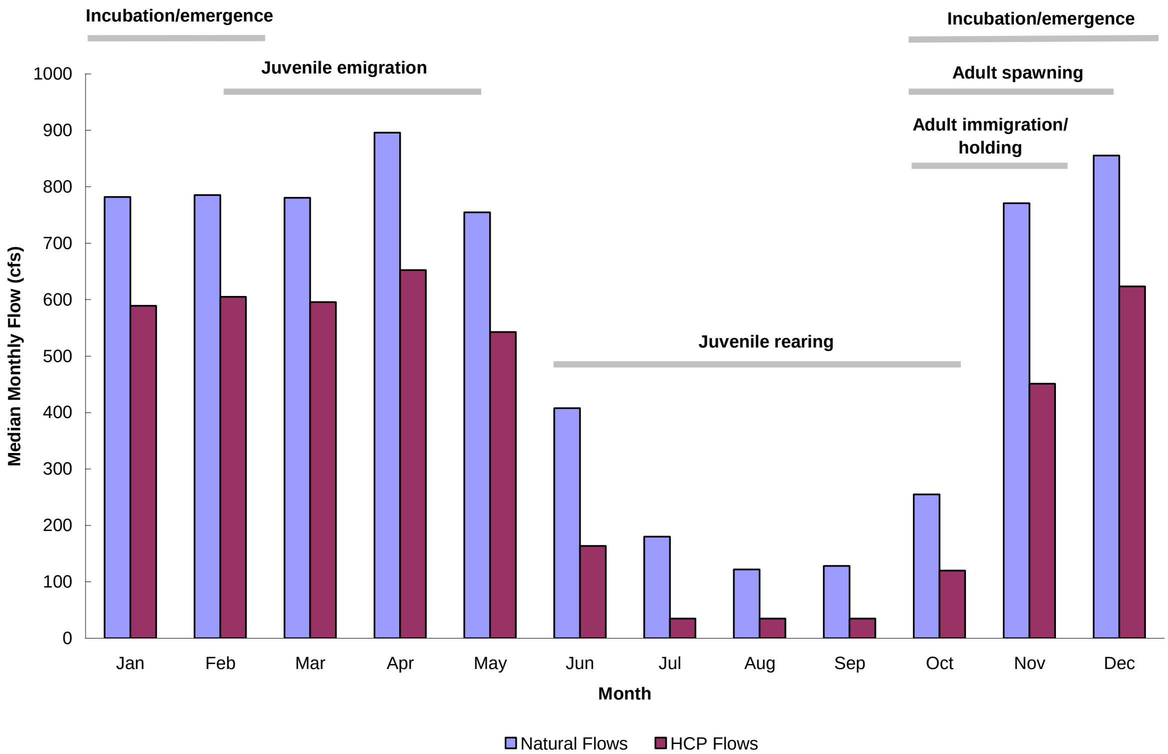


**Figure 8-16. Median Monthly Flows and Peak Periods of Occurrence for Coho Salmon in the Lower Bull Run River above the Little Sandy River Confluence[a]**

Source: Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000 (RM 4.7).
[a]Although peak juvenile rearing period is shown here, coho rearing occurs all year. See Figure 5-37 for periods of occurrence in the lower Bull Run River.

Table 8-40 lists the median natural flows and median flows anticipated from implementing the HCP. The comparison is for flows in two segments: upstream of the confluence with the Little Sandy River (RM 3.0—RM 5.8), and downstream of the Little Sandy River (RM 0–RM 3.0). For the portion of the Bull Run River downstream of the Little Sandy River, median flows were determined using the estimated Little Sandy median natural flows that would occur after the Little Sandy Dam is removed.[11]

[11] See Section 4.1.5 Water Quality and Water Rights for more information about the removal of the Little Sandy Dam.

**Table 8-40. Natural and HCP Median Flows by Month for the Lower Bull Run River**

| | Flows above Little Sandy (cfs)[a] | | Flows below Little Sandy (cfs)[b] | |
|---|---|---|---|---|
| **Month** | **Natural** | **HCP** | **Natural** | **HCP** |
| **January** | 782 | 611 | 938 | 765 |
| **February** | 785 | 608 | 957 | 776 |
| **March** | 780 | 606 | 932 | 760 |
| **April** | 896 | 672 | 1,072 | 846 |
| **May** | 755 | 563 | 898 | 709 |
| **June** | 408 | 196 | 487 | 274 |
| **July** | 180 | 35 | 213 | 67 |
| **August** | 122 | 35 | 141 | 54 |
| **September** | 128 | 35 | 152 | 55 |
| **October** | 255 | 120 | 304 | 166 |
| **November** | 771 | 427 | 924 | 608 |
| **December** | 857 | 654 | 1,031 | 829 |

[a]Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7).

[b]The sum of median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7) and median monthly flows taken at USGS Gauge No. 14141500, Little Sandy River (RM 1.95).

**Effects of Base Flows on Coho Spawning.** The primary spawning period for coho salmon in the lower Bull Run River is October through mid-December (see Figure 5-37). The projected median streamflow under the City's HCP would be approximately 20-50 percent lower than the natural median flows for October through December. However, near optimal habitat conditions still will be provided for spawning coho based on the WUA analysis described below.

**Effects of Base Flows on Coho Rearing.** Flows are consistently highest during the winter and spring period, which will have a minimal effect on coho survival. Projected median flows under the HCP for January through May will be 80-90 percent of the historical median flows in the lower Bull Run River and will range from 600 to 850 cfs. These flows will provide good conditions for incubation and rearing for juvenile coho (R2 Resource Consultants 1998).

The City's HCP flows were also compared with natural flows to determine the difference for the early summer transition and summer/early-fall periods for juvenile coho (June through September). Upstream of the Little Sandy River, the HCP median flows will be 64 percent lower than the natural median flow. Downstream of the Little Sandy, the HCP median flow will be 54 percent lower than the natural median flow. Compared with historical median flows, the City's HCP flows will have a negative effect on juvenile coho during the summer/early-fall flow period. The differences in the two flow levels are further discussed in the following subjection.

**Bull Run Weighted Usable Area.** WUA values were calculated from median flows for coho spawning and rearing to assess the effect of the HCP flow measures on lower Bull Run River habitat. Table 8-41 compares WUA estimates for natural flow conditions (no dams and diversions) with estimates of HCP flows, both upstream and downstream of the Little Sandy River.

R2 Resource Consultants (1998) estimated the flow-habitat relationships for coho spawning and juvenile rearing in the Bull Run River. Using the PHABSIM model, they generated estimates of WUA for up to 500 cfs in four segments of the Bull Run River. The four segments were combined into the two segments of the lower Bull Run River: upstream and downstream of the Little Sandy River. For flows greater than 500 cfs, goodness-of-fit curves were used to extrapolate WUA values.

The WUA estimates for natural and HCP flows are compared using a “percentage of natural” metric. For example, if the HCP percentage of natural flow is 90 percent, the HCP median flow will yield a WUA value of 0.9 acre in a month, and the WUA value would be 1.0 acre in a month.

**Extrapolation above 500 cfs.** Extrapolation is considered to provide conservative WUA estimates (Carlson, pers. comm., 2005), although some uncertainty exists regarding extrapolation of coho spawning WUA values above 500 cfs. That is, the goodness-of-fit curves used to extrapolate WUA values for coho spawning continue to trend upward as flows increase above 500 cfs. However, WUA values for coho spawning may start to decline at higher flow levels, such as those observed by R2 Resource Consultants (1998) in the segment of the Bull Run River below the Bull Run powerhouse (i.e., segment 1). In this segment, PHABSIM modeling to 2,400 cfs was possible, and the modeled WUA values for coho spawning start to decline at flow levels above about 700 cfs (R2 Resource Consultants 1998).

**Estimated WUA for Spawning.** During the primary coho spawning period from October–December, the City’s HCP flow measures will create a total coho spawning WUA ranging from 75 to more than 100 percent of the corresponding natural-flow WUA in the lower Bull Run River (Table 8-41). R2 Resource Consultants (1998) indicated that flows between 130 and 200 cfs create near-optimal conditions for creating total usable habitat values (WUA) for spawning coho (see Figure 5-39).

**Table 8-41. Comparison of Coho Spawning Weighted Usable Area (WUA) Values in the Bull Run River**

| Month | Natural Flow (cfs) | Natural Flow WUA | HCP Flow (cfs) | HCP Flow WUA | Percentage of Natural Flow WUA |
|---|---|---|---|---|---|
| *Above the Little Sandy River* | | | | | |
| **October** | 255 | 1.70 | 120 | 1.27 | 75 |
| **November** | 771 | 3.12 | 427 | 2.45 | 78 |
| **December** | 855 | 3.28 | 654 | 2.90 | 88 |
| *Below the Little Sandy River* | | | | | |
| **October** | 304 | 0.68 | 166 | 0.58 | 85 |
| **November** | 924 | 0.20 | 1.40 | 0.49 | >100 |
| **December** | 1031 | 0.11 | 1.41 | 0.29 | >100 |

Source: R2 Resource Consultants 1998a

The HCP also includes a provision to reduce flows in the fall during water years with critical seasons (see Measure F-2 in Chapter 7). The frequency of these reductions will be limited by the City's commitment. Critical fall flows will only occur in 10 percent of the HCP years. The City's commitment will also limit the occurrence of critical fall flows to no more than two consecutive years. If critical fall flows are triggered, the City will not release critical fall flows in a specific year when most of the resulting adult fish would return to their place of origin. When a critical fall flow year occurs, the City will not implement critical fall flows four years later regardless of whether the critical fall trigger occurs. The measure was developed primarily to protect Sandy River LRW fall Chinook spawning but will also benefit coho salmon. Although it is difficult to analyze the positive effect of this conservation measure on coho because they have a three-year life cycle in the Sandy River Basin (compared with a four- and five-year cycle for fall Chinook), there will be years when the City will provide higher normal year flows in the fall during the coho spawning season.

**Estimated WUA for Rearing.** Coho salmon rear in the lower Bull Run between June and September. The guaranteed minimum HCP flow during this period varies, but is 20 cfs to 40 cfs from July through September. The projected HCP median flow varies from approximately 35 cfs to 270 cfs.

R2 Resource Consultants (1998) estimated that habitat conditions for juvenile coho salmon increase at a rapid rate between 0 and 100 cfs, with the most rapid increase occurring between 0 and 20 cfs (see Figure 5-40). Under the City's HCP flows, the WUA values range from approximately 70 to more than 100 percent of natural flow WUA values for June through September (Table 8-42).

**Table 8-42. Comparison of Weighted Usable Area (WUA) Values for Coho Juvenile Rearing in the Lower Bull Run River**

| Month | Natural Flow (cfs) | Natural Flow WUA | HCP Flow (cfs) | HCP Flow WUA | Percentage of Natural Flow WUA |
|---|---|---|---|---|---|
| *Above the Little Sandy River* | | | | | |
| June | 408 | 13.84 | 196 | 12.89 | 93 |
| July | 180 | 12.67 | 35 | 8.17 | 64 |
| August | 122 | 11.89 | 35 | 8.17 | 69 |
| September | 128 | 11.99 | 35 | 8.17 | 68 |
| *Below the Little Sandy River* | | | | | |
| June | 487 | 9.61 | 274 | 10.31 | >100 |
| July | 213 | 10.47 | 67 | 9.53 | 91 |
| August | 141 | 10.48 | 54 | 9.11 | 87 |
| September | 152 | 10.50 | 55 | 9.15 | 87 |

Source: EDT model run April 17, 2007

**Bull Run Peak Flows.** The HCP flow regime will slightly increase the amount of water diverted from the Bull Run watershed over the term of the HCP, but there will be little change to the magnitude of the Bull Run peak flows. The amount of flow diverted annually from the Bull Run is, on average, 20 percent of the total Bull Run water yield. That percentage is based on flow information from 1946-2004 and current (2006) water demands. Based on the median annual water demands with 2025 projected populations provided by Metro, the percentage of Bull Run diverted will increase to 22 percent. Population growth projections beyond 2025 are not available, and therefore the City could make no assumptions about the percentage of diverted Bull Run yield beyond that year.

The City assessed effects on peak flows in the lower Bull Run River by evaluating the annual peak winter flows since Water Year 1960. This data set was used for the peak flow analysis because the USGS gauge was in another location prior to 1960. The City estimated peak winter flows in the absence of the City's water supply diversions, peak winter flows with current (2006) water diversions, and peak winter flows with estimated 2025 water diversions based on Metro's population projections. The estimated change in annual total water yield diverted for supply is expected to increase from 20 percent currently to 22 percent in 2025.

The estimated magnitude of the annual peaks with no water diversions ranged from 4,010 to 25,420 cfs, depending on weather conditions. The estimated magnitude of the annual peaks for current water demands ranged from 3,880 to 25,100 cfs. The estimated magnitude of the annual peaks for 2025 water demands ranged from 3,863 to 25,094 cfs. Differences were determined by comparing flows on individual peak flow dates. The differences between no diversions and current diversions ranged from 0.3 percent to 3.3 percent. The differences between no diversions and estimated 2025 diversions ranged from 0.6 percent to 3.7 percent.

The City also characterized each peak flow event into a return frequency category (i.e., less than 2-year event, 2–5-year event, 5–10-year event, 10–25-year event, 25–50-year event, and 50–100-year event). The flow conditions experienced in those events were applied to current water diversions and 2025 estimated water diversions. In only one case did the increase in winter season water diversions in 2025 cause a change in the return frequency category for peak events. The January 5, 1969 weather year changed from a slightly greater than 2-year event to a slightly less than 2-year event. The City concluded from this analysis that implementation of the HCP will not significantly change the magnitude of peak flow events in the lower Bull Run River. Peak flow events will continue to occur with a frequency and magnitude similar to current conditions and similar to conditions that would occur without water supply diversions.

**Bull Run Flow Downramping.** The City's hydroelectric plant at the base of Dam 2 varies the streamflow in the lower Bull Run River during the winter and spring months when there is enough streamflow to run the facility. The current FERC license allows for a 2'/hour downramping rate for the lower Bull Run River, but the City is committing to a lower rate (2"/hour) to protect juvenile salmonids.

The City has studied juvenile salmonid stranding during different downramping events in the lower Bull Run River (Beak Consultants 1999; CH2M HILL 2002). The sites selected for monitoring included the widest areas of the channel that were considered most sensitive to ramping effects and stranding. Steelhead fry (about 40 mm average length) and yearlings (Age-1) juveniles were observed during the studies. No other salmonids were present during the stranding studies, and the City has assumed that the observations of juvenile steelhead behavior are adequate for determining potential ramping rates effects. Based on these studies, a ramping rate of no more than 2"/hour was recommended as being protective of salmonids for the lower Bull Run River. This rate is generally what the state of Oregon and others have recommended to protect against juvenile fish stranding (CH2M HILL 2002; Hunter 1992).

The City will avoid or minimize the risk of stranding coho juveniles by maintaining a maximum downramping rate of 2"/hour year-round for the hydroelectric powerhouse downstream of Bull Run Dam 2. Not all impacts from downramping can be avoided, however, due to certain circumstances beyond the control of the City.

The City conducted a year-long evaluation of downramping (Galida 2005) and determined that circumstances when the City would not meet the ramping rate occurred 0.4 percent of the total time. These circumstances included natural storm flows, mechanical/control system failures that are impossible to predict, and FERC mandatory testing of project safety equipment. Out of the test period of approximately 8,800 hours of hydropower operations, the 2"/hour downramping rate was exceeded only for 35 hours. The exceedances occurred from mid-November through late-March, and streamflow in the lower Bull Run River was 200-12,600 cfs. Natural streamflows were quite variable and since the reservoirs were full, the downramping rate could not be controlled by the City for approximately one-third of the 35 hours. Other exceedances can be attributed to equipment testing and operator error. Overall, the City was very successful in controlling the downward fluctuation of the lower Bull Run River.

The City's commitment to a downramping rate of 2"/hour will result in minimal effects on coho. The occurrences of downramping greater than 2"/hour will rarely occur in the future, and if they do, they will happen during the winter months. The primary spawning period for coho in the Bull Run is October and November (see Chapter 5), and near-optimal conditions for spawning and egg incubation occur between flows of 130 and 200 cfs (R2 Resource Consultants 1998). All downramping rate exceedances (>2"/hour) that the City observed were during flows of greater than 200 cfs, and spawning/incubation of coho will not be harmed with the City's downramping measure. Also, there will be a very low potential for stranding juvenile coho because the higher downramps would occur only infrequently and sporadically during the late winter and early spring.

The City will continue to monitor downramping in the lower Bull Run as part of the compliance monitoring efforts (see Chapter 9).

**Little Sandy River Base Flows.** Forgoing development of the City's water rights on the Little Sandy River during the term of the HCP will assure unimpeded natural flows on the Little Sandy River for coho. Coho will have access to approximately 7.3 river miles of the mainstem Little Sandy River and approximately 2 miles of tributary habitat. This measure will increase spawning and rearing habitat for coho, as well as contribute to higher flows in the lower Bull Run River below the Little Sandy confluence, as indicted in Tables 8-41 and 8-42.

### *Water Temperature*

Coho salmon probably utilize the Bull Run River year-round and most of the year the water temperatures are generally cool and acceptable for the species (Figure 8-17). The species spawns in the lower Bull Run in the October through mid-December, emerges from the gravel in the spring, and rears throughout the year (see Figure 5-37 in Chapter 5). The only time of the year when the water temperatures are too warm for the species is during the summer and early fall.

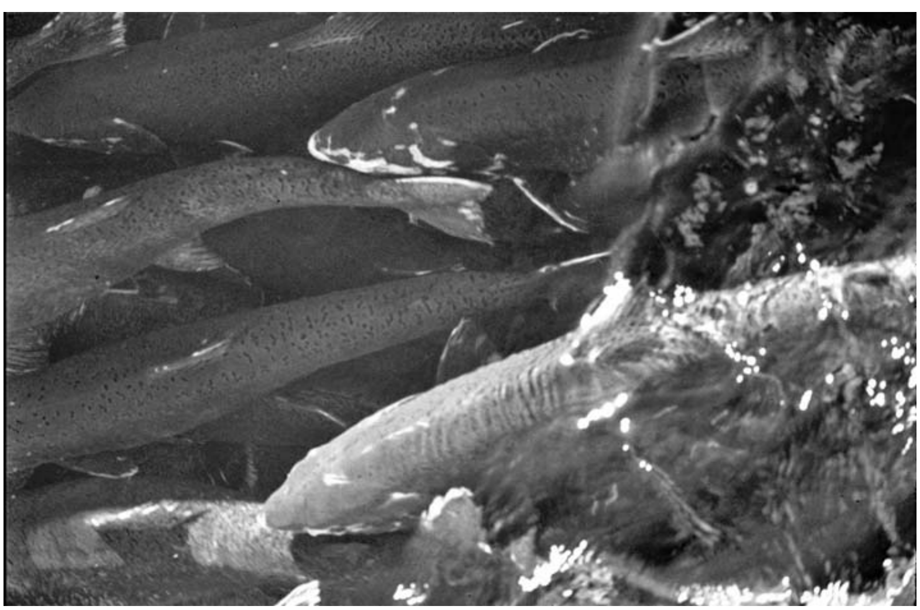

Photo courtesy of Bonneville Power Administration.

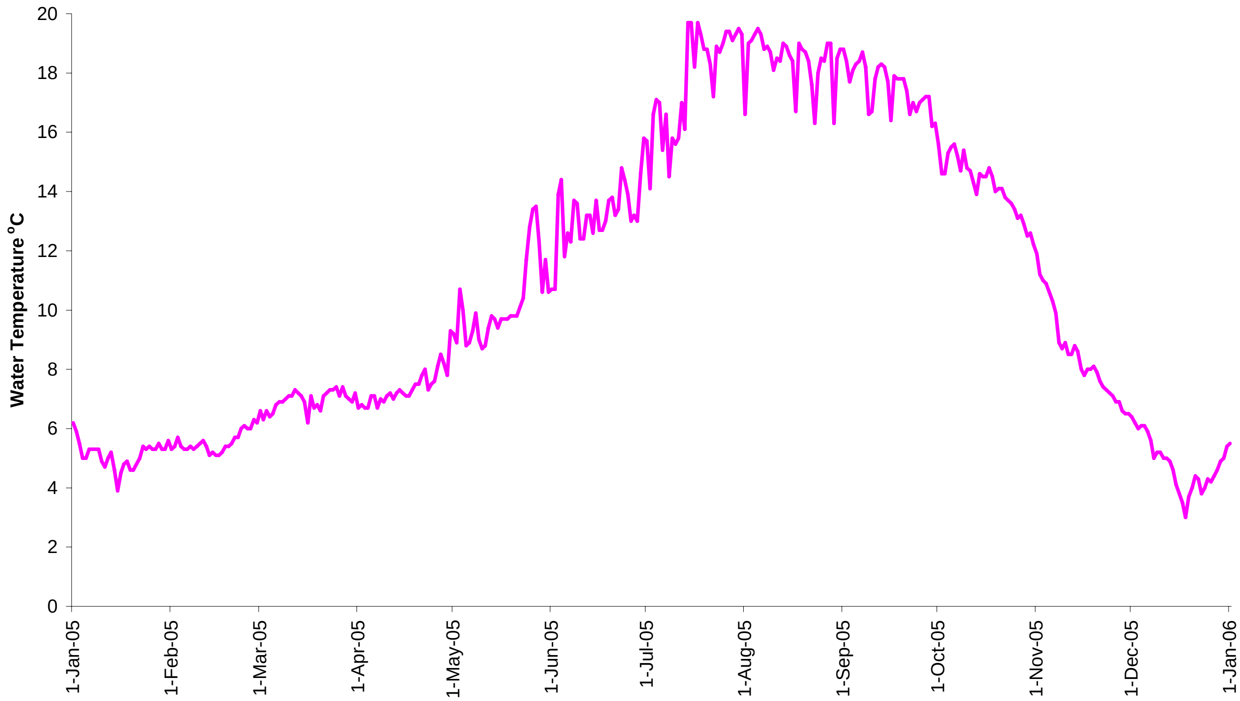


**Figure 8-17. 2005 Daily Maximum Water Temperatures for the Lower Bull Run River as Measured at USGS Gauge No. 14140000 (RM 4.7)**

Source: USGS Gauge No. 14140000 on the Bull Run River (RM 4.7).

The reference condition for water temperature is the natural thermal potential of the lower Bull Run River. Natural thermal potential is defined by ODEQ in the Sandy River TMDL (ODEQ 2005) as the water temperatures that would occur in the Bull Run River if there were no dams or diversion. The City, in conjunction with ODEQ, developed a method to determine the natural thermal potential of the lower Bull Run River and found that the current temperature regime of the Little Sandy River is a good surrogate for the Bull Run. See Measure T-2 in Chapter 7 for more details.

**Pre-Infrastructure Water Temperature Effects.** The City plans to make significant infrastructure improvements at Dam 2 to meet the natural thermal potential of the lower Bull Run River. However, prior to completion of the infrastructure improvements, water temperatures in the lower Bull Run River during the summer and the early part of the spawning season will exceed those preferred by coho (Figure 8-18).

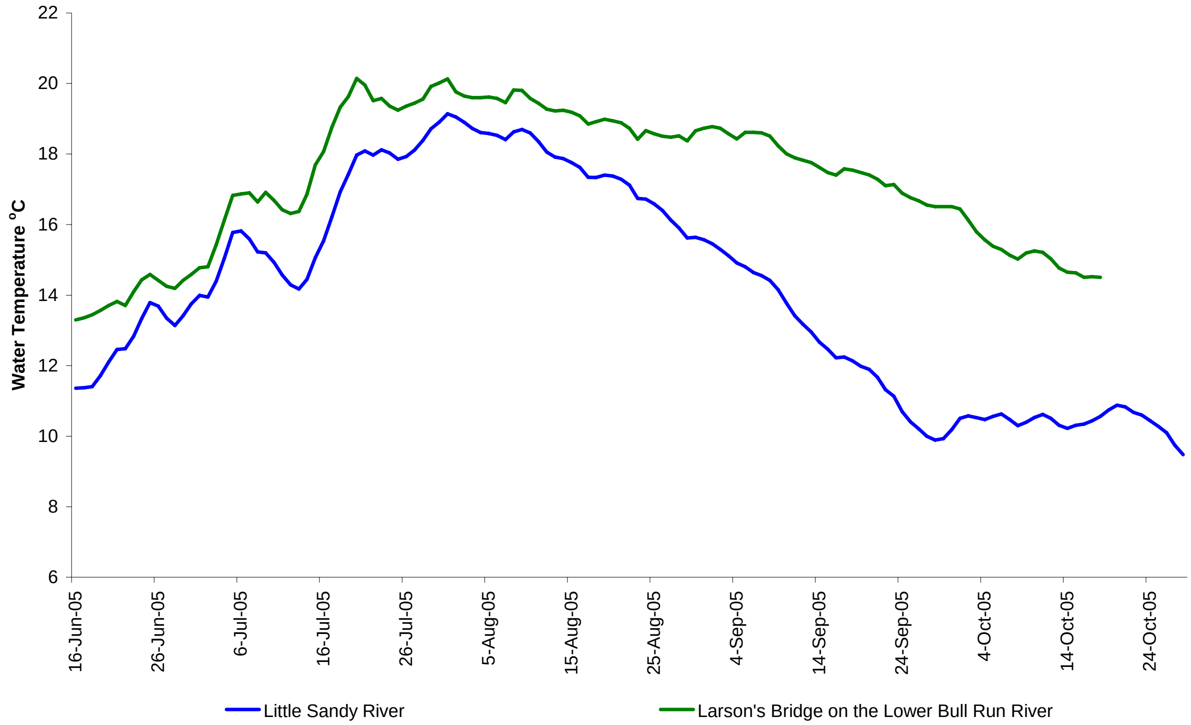


**Figure 8-18. 7-Day Maximum Average Water Temperatures for the Little Sandy and Lower Bull Run Rivers, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and USGS Gauge No. 14140000 on the Bull Run River (RM 4.7).

The City will continue to carefully manage the amount of cool water in the reservoirs for downstream flow releases. Figure 8-18 indicates the water temperature performance that the City will be able to achieve in the first years of the HCP. For spawning coho, the water temperature of the lower Bull Run River, expressed at Larson's Bridge in Figure 8-19, would be approximately 14—16 °C for the first two weeks of October. That is slightly higher than ODEQ's water temperature criterion of 13 °C for spawning salmonids. For rearing coho in the summer and early fall, the City has established the interim goal of not exceeding 21 °C at Larson's Bridge on the lower Bull Run River. That target is cool enough to allow continued growth of coho. While this temperature target is higher than the range preferred by rearing coho, it is the best performance outcome that the City can achieve with the current dam infrastructure. With the City's temperature management, there will be some temporary effects on coho.

Within five years of the start of the HCP, the infrastructure changes at Dam 2 will be completed and the natural thermal potential of the Bull Run River will be met. The pre-infrastructure water temperature effects should be minimal because the water temperature will not be significantly higher than ODEQ's criterion and these conditions should only last approximately five years.

**Post-Infrastructure Water Temperature Effects.** The City will complete infrastructure changes at the Dam 2 towers and the stilling basin and commit to daily operational flow management (Measures T-1 and T-2). The City used the CE-QUAL-W2 water quality model to predict natural condition stream temperatures in the lower Bull Run River (City of Portland 2004). The model predicted that maximum stream temperatures would occur at Larson's Bridge (RM 3.8) in the lower Bull Run River. City staff and ODEQ staff evaluated modeling results and empirical data and concluded that natural stream temperatures in the lower Bull Run River could be estimated using the stream temperature of the Little Sandy River (Figure 8-19).

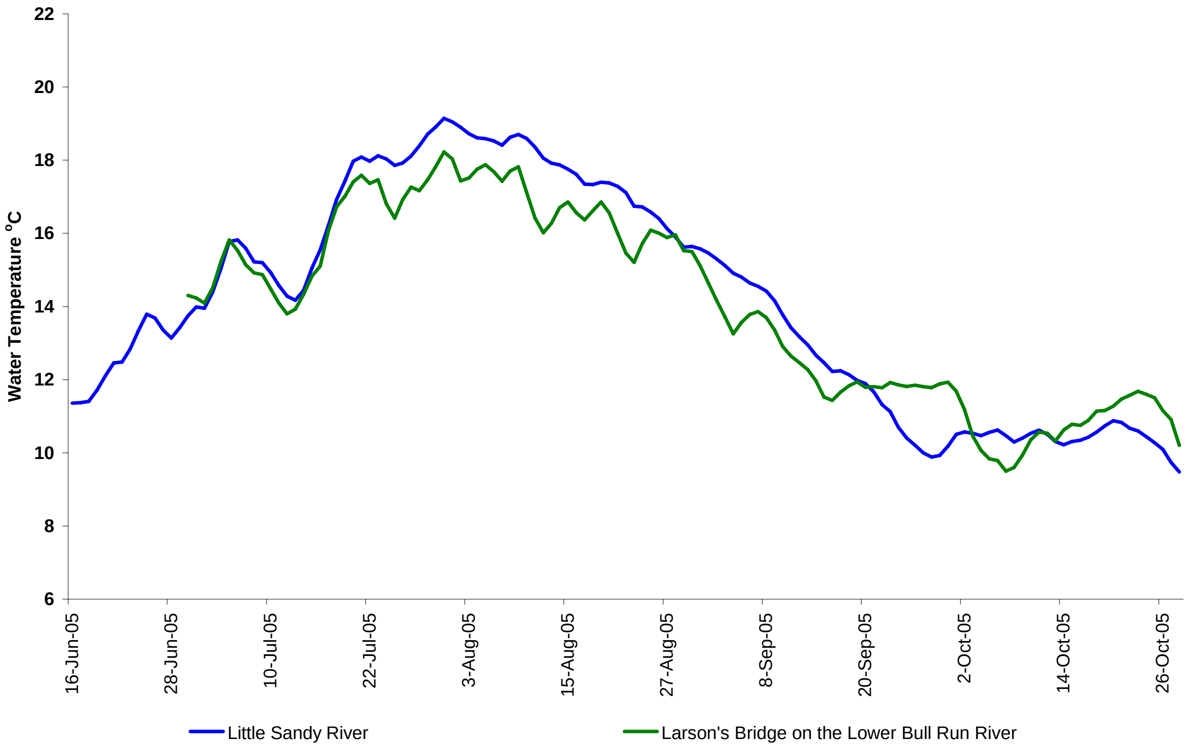


**Figure 8-19. Comparison of Actual 7-Day Maximum Water Temperatures for the Little Sandy Compared with Predicted 7-Day Maximum Average Temperatures for the Lower Bull Run River, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and CE-QUAL-W2 Modeled Temperatures (February 2006).

The summer and early fall water temperatures in 2005 indicate that water temperatures at Larson's Bridge will be generally lower than temperatures in the Little Sandy but are within approximately 1 °C (see Figure 8-19). ODEQ has established water temperature criteria for the Larson's Bridge location under the authority of the CWA and the Sandy River Basin TMDL (see Measure T-2 in Chapter 7).

Within 5 years of the start of the HCP, the infrastructure changes at Dam 2 will be completed and the natural thermal potential of the Bull Run River will be met.  Water temperature impacts on coho would be minimized.

**Diurnal Water Temperature Fluctuations.** Diurnal water temperature fluctuations likely to result from implementing the HCP measures were estimated using modeling and measured Little Sandy River water temperatures. Table 8-43 lists observed and expected temperature fluctuations for the summer and late summer months. These are the months when the City's implementation of the water temperature measure (Measures T-1 and T-2) will affect diurnal temperature fluctuations. The fluctuations expected after implementing the HCP measures are predicted to be smaller than the fluctuations that would occur under natural conditions.

**Table 8-43. Diurnal Water Temperature Fluctuations (°C)**

| | Temperature Fluctuations (°C) | | |
|---|---|---|---|
| **Month** | **Bull Run Observed (current conditions)** | **Little Sandy Observed (natural conditions)** | **Expected Under HCP** |
| **June** | 4-6 | 0.5-5 | 2-3 |
| **July** | 4-6 | 1-5 | 2-3 |
| **August** | 3-5 | 1-5 | 2-3 |
| **September** | 2-3 | 1-4 | 1-2 |

Source: Bull Run observed temperatures: USGS Gauge No. 14140000 on the Bull Run River (RM 4.7); Little Sandy observed temperatures: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8); expected HCP temperatures: CE-QUAL-W2 Modeled Temperatures (February 2006).

The City reviewed available research on the influence of fluctuating water temperature on the growth of salmonids. Experiments on steelhead and coho (Hahn 1977; Grabowski 1973; and Thomas et al. 1986) indicated that fluctuating water temperature tests and the constant test exposures produced equivalent results. The City concludes that the reductions in diurnal water temperature fluctuations will not affect coho salmon or other salmonids that utilize the lower Bull Run River.

*Large Wood*

Large wood is removed from the upper end of Reservoir 1 to protect the downstream water supply dams from damage. USFS owns this wood because it is transported by tributaries from national forest land. Because the wood is not allowed to travel down the lower Bull Run River, a small amount of beneficial habitat for coho may be lost. The lower Bull Run River is, however, a high-order steep stream, and is not likely to trap and store large wood. Photographs taken of the lower Bull Run in the late 1890s, before the dams and water diversions were constructed, show little large wood in the channel. The lower river is probably a transport reach for large wood.

The lower Bull Run River is dominated by bedrock and boulders. This channel roughness supports diverse habitats, including about 27 percent pool habitat. The presence of this pool habitat suggests that large wood is not an important requirement of pool formation, and the addition of large wood would provide only a minor increase in pool habitat.

The City does not plan to artificially place large wood in the lower Bull Run River above Larson's Bridge because of concerns about the vulnerability of water supply infrastructure (i.e., conduit trestles). The City will let natural recruitment of large wood occur downstream of Larson's Bridge. Trees that fall naturally will be left in place to modify the stream channel as long as the water conduits and bridges are not threatened. This large wood could slightly improve habitat conditions for coho by reducing the overall grain sizes and creating pools in localized areas in the lower 3.8 miles of the Bull Run River.

### *Spawning Gravel*

The two Bull Run dams interrupt bedload and gravel movement to the lower Bull Run River, resulting in reduced spawning habitat for coho salmon and other salmonid species. The estimated historic gravel supply rate was roughly 30—1,000 cubic yards (CH2M HILL 2003b). The City will place approximately 1,200 cubic yards per year for the first five years and 600 cubic yards per year thereafter (see Measure H-1 in Chapter 7). The City will monitor the effects of the gravel placement to determine whether the measure should continue for the term of the HCP or should be modified. The gravel replacement rate will be higher than the estimated natural accumulation. Placement of gravel in the lower Bull Run River should significantly improve the spawning conditions for coho salmon.

### *Access*

Coho salmon were first blocked from the upper Bull Run watershed in 1921 by construction of the Diversion Dam (approximately RM 5.9). That dam diverted Bull Run water into conduits to serve the greater Portland metropolitan area. In 1964, as part of the Dam 2 construction, a rock weir was built at RM 5.8 to create the Dam 2 plunge pool for energy dissipation. The rock weir is now the upstream limit for coho. Coho access is also blocked at the mouth of Walker Creek, a tributary to the Bull Run River. Historically, about 800 feet of this stream was probably used by coho salmon.

Coho access will remain blocked at the rock weir (RM 5.8). Continued operation of the City's water supply operation will block coho access to approximately 21.3 miles of the upper Bull Run River. Of these blocked miles, 12.1 are free-flowing river and 9.2 river miles are inundated by City reservoirs. The City will provide access to Walker Creek as part of its HCP. A culvert or other appropriate structure that meets fish passage criteria will be constructed so that coho will have access to this tributary of the Bull Run River.

When PGE removes the Little Sandy Dam, coho will have access to an additional 5.6 river miles of the mainstem Little Sandy River and possibly 2.0 miles of tributary streams. The City's agreement to maintain flows for fish in the Little Sandy (see Measure F-4, Chapter 7) will help retain habitat benefits from this renewed access to historic coho habitat.

The City will also improve access for coho in Alder Creek, which is a tributary to the middle Sandy River.  This effect is described below in the Offsite Habitat Effects section.

### *Riparian Function*

The City owns land along 5.3 miles of the lower Bull Run River (1,650 acres). The City's lands represent 82 percent of the riparian corridor below Dam 2. Managing these lands to protect riparian habitat (see Measure H-2 in Chapter 7) will improve habitat for coho salmon. Approximately 30 percent of the riparian corridor along the lower river is in late-successional (late-seral) timber that can provide immediate large wood recruitment to the channel. Further, 80 percent of the riparian corridor is of mid- to late-seral age and will provide wood to the channel at an increasing rate over the next 10 to 70 years (Cramer et al. 1997).

Additional analysis of shading in the lower Bull Run River indicates that riparian vegetation currently intercepts 40 to 60 percent of the total solar radiation that potentially could reach the water surface (Leighton 2002). This level of shading provides a substantial benefit by maintaining lower water temperatures. This shading benefit will become greater over time as the vegetation continues to mature. The mature vegetation in the lower Bull Run combined with the results the temperature measures (infrastructure changes to the intake towers and temperature management) will closely approximate natural water temperatures and reduce the effects of water system operations on coho salmon.

***Total Dissolved Gases***

Oregon's Water Quality Standards state that TDG levels should not exceed 110 percent of saturation unless flows exceed the ten-year, seven day average flood (7Q10) flow for the site [OAR 340-041-0031]. The 7Q10 flow for the lower Bull Run River is 5,743 cfs. The City has monitored all water system structures, valves, or turbines that could elevate TDG levels since 2005 and has determined that coho are unlikely to be adversely affected by TDG levels in the Bull Run River. A 55-foot deep stilling pool at the base of the Dam 2 spillway is the site most likely to produce TDG levels that could affect coho. This location, however, is upstream of the range of anadromous fish. Monitoring by the City indicates that elevated levels of TDG quickly decrease as water passes over the rock weir below the stilling pool (RM 5.8). The City has never measured TDG levels that met or exceeded 110% in the anadromous portion of the Bull Run River, unless the 7Q10 flow was also exceeded. TDG levels further dissipate between the rock weir and Larson's Bridge. All of the coho observed in the lower Bull Run River were downstream of Larson's Bridge (Strobel 2007a, Clearwater BioStudies 1997; 2006, ODFW 1998; Beak Consultants 2000a,b). Coho are probably not impacted by TDG levels in the Bull Run River. The City will continue to monitor TDG levels in the Bull Run as described in the Effectiveness Monitoring section in Chapter 9 and Appendix F, Monitoring Plans and Protocols.

**Summary of Effects on Coho Salmon in the Lower Sandy River from Bull Run Water Supply Operations and HCP Measures**

The City identified four types of effects that water supply operations and the HCP measures will have on coho habitat in the lower Sandy River.

- Base flows in the lower Sandy would be reduced by continued water supply operations in the Bull Run watershed. Under the City's HCP measures, these base flows will not have negative effects on coho in the lower Sandy River.
- Flow downramping effects in the lower Sandy will be avoided because of the City's downramping commitments in the Bull Run.
- The City's HCP measures will probably have small beneficial effects on water temperatures in the lower Sandy.
- The City will also minimize the impact of removing large wood from the lower Bull Run by adding large wood directly into the lower Sandy.

Overall, the City's HCP measures will have positive effects on coho habitat in the lower Sandy River. Table 8-44 summarizes the habitat effects of the Bull Run measures in the lower Sandy.

**Table 8-44. Effects of the Bull Run Measures on Lower Sandy River Habitat for Coho Salmon[a]**

| Type of Effect | Reference Condition | Habitat Effects of Conservation Measures |
|---|---|---|
| Base Flows | Natural Sandy River base flows | Flows after implementation of the HCP will be more than 80% of natural base flows.[b] |
| Weighted Usable Area | Natural Sandy River base flows | No adverse effects are expected for coho (R2 Resource Consultants 1998). |
| Flow Downramping | Protective downramping rate: 2"/hour | The City's water supply operations will have minimal effects on fish stranding caused by downramping. |
| Water Temperature | ODEQ standard: natural thermal potential | The City's HCP measures will probably have small water temperature benefits. |
| Large Wood | Natural wood accumulation | Removal of large wood from the reservoirs reduces the amount of large wood loading to downstream Sandy River reaches and reduces channel complexity.<br>City measures will increase large wood levels and habitat diversity, minimizing adverse effects of Bull Run operations in the Sandy River below the Bull Run confluence. |

[a]For the list of conclusions about the habitat effects of all HCP measures on coho salmon, see page 8-151.

[b]Based on flow data from 1985-2001, natural base flows were reduced by 4-19 percent (CH2M Hill 2002).

### Habitat Effects in the Lower Sandy River from the Bull Run Measures

The EDT database and model were used to identify limiting factors having the greatest impact on coho salmon in the lower Sandy River below the confluence with the Bull Run River. The factors identified were food, habitat diversity, harvest, flow, channel stability, competition from the same species, predation, water temperature, pathogens, and sediment. Of these 10 factors, three are potentially affected by water supply operations in the Bull Run: flow, water temperature, and large wood recruitment (as a subfactor in habitat diversity). The other seven factors are not directly related to water supply operations.

#### *Streamflow*

The City includes several flow measures to improve conditions for coho in the lower Sandy River, but information specific to coho utilization is lacking. A flow effects analysis was completed for Chinook salmon and steelhead in the lower Sandy River below the Bull Run (CH2M HILL 2002).[12] The City assumes that the general benefits described for Chinook and steelhead would also benefit coho. Coho primarily use the Sandy River below the Bull Run confluence for rearing and emigration; very little coho spawning occurs in the lower Sandy River mainstem. The CH2M HILL analysis focused on the potential effects of the City's Bull Run operations on base flows and on flow fluctuations (ramping). The analysis used Bull Run flows from 1985 to 2001, which are lower than the HCP flows as described in Chapter 7.

**Base Flows.** The City compared the WUA (for Chinook and steelhead) and monthly flow amounts without City operations to the WUA and monthly flows during the 1985 to 2001 period. City operations from 1985 to 2001 reduced base flows in the lower Sandy River by 4 to 19 percent (depending on month), but increased habitat for Chinook and steelhead spawners. The CH2M HILL analysis (2002) concluded that Chinook and steelhead spawning and rearing in the lower Sandy River would not be adversely affected by the City's operations, even at lower flows than those described in Measure F-1 in Chapter 7. R2 Resources Consultants (1998) similarly concluded that flow enhancement in the lower Bull Run River would have little or no beneficial effect on spawning and rearing salmon and steelhead in the lower Sandy River.

**Downramping.** The CH2M HILL (2002) analysis indicates that a downramping rate of 2"/hour would eliminate juvenile salmonid stranding in the lower Bull Run River. Given the analysis above about base flow effects, the HCP downramping measure is also expected to minimize any potential juvenile stranding effect in the lower Sandy River.

#### *Water Temperature*

Both ODEQ's and the City's water temperature modeling results indicate that the lower Sandy River reaches are in a state of relative equilibrium. City water supply operations have little influence on heating or cooling of the lower Sandy River. This conclusion is supported in the Sandy River Basin TMDL (ODEQ 2005).

Although the City's operations in the Bull Run will not negatively affect water temperatures in the lower Sandy River, some of the City's offsite conservation measures will probably have small water temperature benefits (see page 8-140 for effects on the lower Sandy watershed).

[12] The CH2M HILL study was based on an instream flow study completed for the lower Sandy River (Beak 1985). The Beak study did not develop flow versus habitat relationships for coho salmon.

### *Large Wood*

Removal of large wood from the Bull Run reservoirs reduces the amount of large wood loading to downstream Sandy River reaches and reduces channel complexity for salmonids. To mitigate for this impact, the HCP includes several large wood measures in the lower Sandy River (see Measures H-4, H-11, H-12, and H-13 in Chapter 7).

## Habitat Effects in the Columbia River from Use of Groundwater

The City will use groundwater from the Columbia South Shore Well Field in conjunction with the Bull Run River flows to provide the total amount of water needed to meet water supply demands and the HCP flow commitments. The Columbia River is adjacent to the well field, so the City analyzed the effect groundwater use might have on flows in the Columbia River.

As context, only one instream flow commitment has been established for the lower Columbia River to maintain the persistence of ESA-listed species. This requirement is the FCRPS's minimum flows of roughly 125,000 cfs below Bonneville Dam, unless competing priorities preclude it (USCOE et. al. 2006). These minimum flows are increased by contributions from the Sandy and Washougal rivers before arriving at the Glenn Jackson Bridge (I-205 bridge), approximately 14 miles west of the mouth of the Sandy River.

The well field has an estimated sustainable capacity of approximately 85 mgd, which is equivalent to approximately 130 cfs. The actual amount and duration of pumping will vary according to the weather and supply conditions, but typically the amount pumped per day would be significantly less than the full capacity. The well field draws on four regional alluvial aquifers. Recharge for these aquifers occurs as far south as the Boring Hills (Hartford and McFarland 1989). These aquifers generally discharge into the Columbia River.

As a simplifying worst-case assumption for this analysis, the City assumed that 85 mgd would be pumped from the well field and that this amount would be drawn into the aquifers from the Columbia River. (This is a significant overestimate because the water pumped would actually be drawn primarily or completely from the aquifers themselves and not from the river into the aquifers.) The assumed flow into the aquifers would reduce the assumed flow available in the Columbia River for fish.

If the City's groundwater pumping were to result in a 130 cfs reduction in Columbia River flows, that reduction would be at most 0. 1 percent of the total river flow (based on the 125,000 cfs minimum flows mentioned above). To put this reduction in perspective, the typical margin of error on measured flows for the Columbia River is +/- 10 percent (see, for example, the gauge at the Columbia River at The Dalles, USGS 2003). This measurement error is significantly larger than the estimated flow reduction due to groundwater use. In addition, the mainstem Columbia River has tidal fluctuations that average approximately 1.7 feet (data from USGS Gauge No. 14144700). This natural daily change in river stage is many orders of magnitude greater than any potential reduction of Columbia River flows due to the City's use of groundwater. The City's conclusion is, therefore, that use of the Columbia South Shore Well Field as a means to enable the HCP flow commitments in the lower Bull Run River will have a negligible influence on the Columbia River base flows and associated habitat for coho salmon migrating in the river.

### Summary of Effects on Coho Salmon in the Sandy River Basin from the HCP Offsite Measures

The HCP offsite measures in coho production areas are included to mitigate effects that cannot be avoided in the lower Bull Run River.[13] The upper Sandy River Basin, upstream of the Marmot Dam site, has almost all of the coho anchor habitat reaches. The HCP measures in the upper Sandy will improve riparian zone and channel conditions, increase side channel habitat, and increase large wood loads over time. The City will implement measures to benefit coho in the Middle Sandy River watershed, including riparian easements and improvements, large wood placement, and removal of passage barriers on Alder and Cedar creeks. Although the HCP measures in the lower Sandy River were selected with the primary intent to improve habitat conditions for fall Chinook, some benefits will accrue for coho as well.

- The improvements in the Little Sandy River will increase spawning and rearing habitat and provide cover for juveniles.
- Reduced risk of peak flow displacement, increased rearing and overwintering habitat, and improved habitat diversity will benefit juveniles in the lower and middle Sandy River and Boulder Creek.
- The HCP measures in the lower Sandy River will also provide escape cover for juveniles and improve adult passage.
- Small temperature benefits in the lower and middle Sandy River will improve parr productivity and egg incubation, respectively.
- The improvements in Gordon Creek will provide habitat diversity for rearing juveniles, provide habitat for overwintering juveniles, and improve egg incubation.
- Passage improvements in Alder and Cedar creeks will provide access to approximately 17 new stream miles for coho.
- In the upper Sandy River, all juvenile life stages will benefit from the increase in habitat diversity; rearing parr, fry, and spawners will benefit from the large wood loading, which will create pool habitat.
- The improvements in the Salmon River will increase the amount and diversity of key habitat for juveniles and increase spawning habitat. Over time, the riparian easements will provide small slight temperature benefits and cover for juveniles, and will help reduce bed scour. Carcass placement will improve food availability in the first year.
- Details of the specific improvements in coho habitat that will result from the offsite measures are described in this chapter and in Appendix E. Overall, the City's offsite conservation measures will improve habitat for coho in the Sandy River Basin.

[13] Effects in the lower Bull Run River include reduced base flows and weighted usable areas and blocked access to the upper Bull Run watershed.

### Habitat Effects in the Sandy River Basin from the HCP Offsite Measures

The City's HCP includes 30 offsite habitat conservation measures. Most of these actions address environmental problems affecting the production of more than one species. This analysis describes the effects of the HCP measures on coho salmon. Effects are described by watershed and address both coho life stages and limiting factors. (See Chapter 5 for additional information on the coho population in the Sandy River Basin and the habitat factors that limit production.)

#### *Little Sandy River*

The City's water supply operations do not affect the Little Sandy River because it is a tributary to the lower Bull Run River downstream of the City's dams and diversion. The City's large wood habitat conservation measure for the Little Sandy River was selected to improve habitat diversity for spawning and rearing habitat for coho and other salmonids.

The City will place large wood in the Little Sandy River (see Measure H-3 in Chapter 7), which will slightly increase channel complexity and gravel sorting for coho and other fish species. Coho habitat should slightly improve with the large wood additions. The large wood will add channel complexity and create low-velocity areas for overwintering coho juveniles and will modify the channel hydraulics of the Little Sandy River and trap suitable spawning gravel.

#### *Lower Sandy River Watershed*

The lower Sandy River watershed consists of the 18.5 miles of the Sandy mainstem between the Bull Run and Columbia river confluences (Sandy 1 and 2 reaches), plus the following tributaries: Beaver, Buck, Gordon, and Trout creeks. Coho spawn in the tributaries of this watershed but not in the mainstem Sandy River to an appreciable degree. This may be a result of years of releases from Sandy Hatchery combined with historical passage difficulties below the former Marmot Dam. Currently, coho spawn in the lower 7.3 miles of Gordon Creek and the lower 0.75 mile of Trout Creek, and in lesser numbers in the lower 0.5 mile of Buck Creek and the lower 7 miles of Beaver Creek.

HCP measures were selected in the lower Sandy River with the intent to mitigate effects on coho salmon that cannot be avoided in the Lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The analysis considers beneficial effects for coho that are likely to result from measures designed primarily for other species.

The City will implement measures in this watershed to benefit coho, including a reconnected side channel, reestablished mouth, riparian restoration, and engineered log jams on the lower Sandy mainstem, as well as large wood placement and riparian enhancements in Gordon and Trout creeks. A detailed description of each measure and the affected reaches is available, by watershed, in Chapter 7.

Table 8-45 lists the reaches affected by HCP measures planned in the lower Sandy River and the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-45. Habitat Benefits for Coho in the Lower Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Beaver 1A | Riparian function | Improvement |
| | Large wood | Increase |
| Gordon 1A | Fine sediment in gravel patches | Decrease |
| | Backwater pools | Increase |
| | Large-cobble riffles | Decrease |
| | Pool habitat | Increase |
| | Pool-tail habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Gordon 1B | Backwater pools | Increase |
| | Pool habitat | Increase |
| | Pool-tail habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 1 | Artificial confinement | Reduction |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Large wood | Increase |
| Sandy 2 | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Trout 1A | Large wood | Increase |
| Trout 2A | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

The City's HCP measures will substantially increase large wood in the mainstem Sandy River, improve riparian function, and create a large quantity of key side-and off-channel habitat for juvenile coho. The additional large wood will stabilize the stream channel to some degree, lessen peak flow displacement risks to fry and overwintering juveniles, and provide escape cover from predators. The improved riparian function will moderate temperatures to some degree, which in turn will improve parr productivity.

In Gordon and Trout creeks, the increase in large wood will have a commensurate increase in pools, backwater pools, and pool tail-outs for parr and overwintering juveniles. The gravel trapped by the newly installed log structures will also improve channel stability for incubation and overwintering juveniles. In Gordon Creek, the riparian enhancement project on the lowermost reach will stabilize crumbling banks and reduce the amount of sediment in spawning gravels.

### *Middle Sandy River Watershed*

Most of the middle Sandy River mainstem is carved through bedrock in a deep, steep-walled gorge. Coho primarily use this river segment as a migration corridor (SRBP 2005). The main impact to habitat quality in the mainstem middle Sandy has been Marmot Dam, which is outside the authority of the City and was decommissioned in July 2007.

Upstream of the Marmot Dam site, little spawning occurs in the middle Sandy, except in the inflow reach of the Marmot Dam site. This reach (Sandy 6) provides exceptional mainstem spawning and rearing habitat with a low gradient, pools, riffles, side channels, and relatively abundant cobble/gravel substrate and large wood.

The portions of Alder and Cedar creeks that are accessible to coho support natural productivity. A weir constructed in the early 1950s partially blocks fish passage approximately 0.5 mile upstream from the mouth of Cedar Creek (SRBP 2005).

The HCP measures were selected in the middle Sandy River with the intent to mitigate effects on coho salmon that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The analysis considers beneficial effects for coho that are likely to result from measures designed primarily for other species.

The City will implement measures that will benefit coho in the middle Sandy River watershed, including riparian easements and improvements, carcass placement, large wood placement, and water rights purchases. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

The City will modify two structures in Alder Creek and one in Cedar Creek, which are tributaries to the middle Sandy River. The City will also purchase available water rights in Cedar Creek (see Measure F-5, Chapter 7) to improve habitat conditions for coho and other species. Currently, coho use the lowest reach of Cedar Creek. After the modifications are made, approximately 5.5 river miles will be accessible for coho salmon in Alder Creek and approximately 12 miles in Cedar Creek.

Table 8-46 lists the reaches affected by HCP measures planned in the middle Sandy River and summarizes the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-46. Habitat Benefits for Coho in the Middle Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Alder 1 | Large wood | Increase |
| | Blocked access | Increase |
| Alder 1A | Riparian function | Improvement |
| | Blocked access | Increase |
| Alder 2 | Riparian function | Improvement |
| | Large wood | Increase |
| Cedar 1 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Minimum water temperature | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| | Blocked access | Increase |
| Cedar 2 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Minimum water temperature | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| | Large wood | Increase |
| Cedar 3 | Dissolved oxygen | Increase |
| | Fish pathogens | Improvement |
| | Beaver pond habitat | Increase |
| | Off-channel habitat | Increase |
| | Pool habitat | Increase |
| | Riparian function | Improvement |
| | Minimum water temperature | Decrease |
| | Maximum water temperature | Decrease |
| | Temperature moderation by groundwater | Improvement |
| | Large wood | Increase |
| Sandy 3 | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Table continued on next page

**Table 8-46. Habitat Benefits for Coho in the Middle Sandy River Watershed, by Reach, continued**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Sandy 7 | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

The City does not know how much flow might be returned to Cedar Creek from purchasing existing surface water rights, and therefore the benefits of the action can only be generally described as an increase in base flows over existing conditions as a result of the City's commitments.

The riparian easements and improvements in the middle Sandy River and Cedar and Alder creeks will protect intact portions of the riparian corridor, improve the arboreal species composition (by culling hardwoods and planting conifers), and allow for related habitat improvements (such as large wood recruitment, decrease in temperature, and increase in food availability) to occur over time. Large wood placement will increase channel stability to some degree for all life stages, decrease the risk of displacement by peak flows for fry and overwintering juveniles, and improve habitat diversity for juveniles. Large wood placement above the hatchery weir in Cedar Creek will increase key habitat for fry and parr substantially. The elimination of two migration barriers in Alder Creek will give coho access to approximately five new stream miles.

### *Upper Sandy River Watershed*

Most of the upper Sandy River watershed is located in the Mt. Hood Wilderness and receives little anthropogenic disturbance. With the exception of the lowermost reach (Sandy 8), coho production is limited by naturally occurring conditions. Sandy 8 has been straightened, cleaned of large wood and large boulders, and confined between riprapped banks in response to the 1964 flood and due to development that has occurred between the communities of Zigzag and Brightwood.

The City will implement a measure in reach Sandy 8 to benefit coho salmon, a riparian easement. A detailed description of the measure and the affected reach is available in Chapter 7.

Table 8-47 lists the reach affected by the HCP measure planned in the upper Sandy River watershed and summarizes the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-47. Habitat Benefits for Coho in the Upper Sandy River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Sandy 8 | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

The improvement in riparian function and large wood will improve habitat diversity for all juvenile life stages and will reduce channel instability, thus improving incubation. The increase in large wood loading will result in increased pools and pool tail-outs, thereby creating key habitat for fry, parr, and, to a lesser degree, spawners. The improved riparian function and carcasses that wash out of the Zigzag River into the upper Sandy reaches will boost food production for all juveniles.

***Salmon River Watershed***

Coho spawn and rear in the lower 13.2 miles of the Salmon River (reaches 1–3), as well as the lower 4.4 miles of its Boulder Creek tributary.

HCP measures were selected in the Salmon River with the intent to mitigate effects on coho salmon that cannot be avoided in the lower Bull Run River. These effects include reduced base flows, elevated water temperature, reduced habitat diversity, reduced spawning habitat, and impaired access to the upper reaches of the river. The City also considered the habitat factors that are limiting productivity of coho in Boulder Creek. The analysis considers beneficial effects for coho that are likely to result from measures designed primarily for other species. The City will implement measures in the Salmon River watershed to benefit coho salmon, including purchasing riparian easements, acquiring and restoring the Miller Quarry property, adding large wood to Boulder Creek, and adding salmon carcasses. A detailed description of each measure and the affected reaches, by watershed, is presented in Chapter 7.

Table 8-48 lists the reaches affected by HCP measures planned in the Salmon River and summarizes the expected habitat benefits in each reach (see tables in Appendix E for percentages for reference condition and post-implementation values).

**Table 8-48. Habitat Benefits for Coho in the Salmon River Watershed by Reach**

| Reach | Reference Condition | Habitat Benefit |
|---|---|---|
| Boulder 0 | Fine sediments by surface area | Decrease |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Boulder 1 | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 1 | Off-channel habitat | Increase |
| | Small-cobble riffles | Decrease |
| | Riparian function | Improvement |
| | Carcasses per stream mile | Increase[a,b] |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 2 | Average depth of bed scour | Reduction |
| | Artificial confinement | Reduction |
| | Off-channel habitat | Increase |
| | Riparian function | Improvement |
| | Maximum water temperature | Decrease |
| | Large wood | Increase |
| Salmon 3 | Large wood | Increase |

Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures. Post-implementation values are cumulative benefits expected from individual restoration projects that affect the same attributes in the same reach (see Appendix E).

[a]This habitat benefit was not included in the EDT model run used to determine the effects of the HCP measures on adult salmon and steelhead abundance.

[b]Salmon carcass placement is a one-time treatment.

The measures implemented in the Salmon River watershed will increase the amount and diversity of habitat for coho juveniles. The riparian easements and enhancements will protect important and intact portions of the riparian corridor, improve the arboreal species composition (by culling hardwoods and planting conifers), and allow the natural improvements in habitat (such as habitat diversity, large wood recruitment, security cover, food production, and temperature moderation) to occur over time.

The Miller Quarry actions will restore connectivity of the mainstem Salmon River with flood plains and side channels which will add key habitat, reduce bed scour, and increase large wood loading, benefiting all juvenile life stages.

The riparian enhancements and large wood placement in Boulder Creek will increase habitat diversity for all juvenile life stages and reduce fry displacement during peak flow events. Some measure of these benefits will propagate downstream.

The salmon carcasses that will be placed in the Salmon River will temporarily reduce food scarcity both in the Salmon River and downstream reaches.

**Summary of Population Effects and VSP Parameters**

The VSP parameters for productivity, diversity, and abundance for the Sandy River population of coho are projected to increase by 4–17 percent under the HCP.* The projected increases in the VSP parameters should also be considered as modest because they do not include any potential benefits to steelhead that may be derived from projects supported by the City's $9 million Habitat Fund (see Measure H-30, Chapter 7).

*If Cedar Creek weir removal is included, the VSP parameters are expected to increase by 4 to 25 percent.

## Population Effects and VSP Parameters

The HCP habitat conservation measures were designed to mitigate the effects of the Bull Run water supply on coho salmon and other covered species. This section describes the estimated effects of the City's HCP on the overall Sandy River coho salmon population using parameters established in the NMFS recovery planning process, specifically the work of the LCR-TRT.

Sandy River coho are part of the Lower Columbia ESU. The benefits to the Lower Columbia ESU from this HCP cannot be overstated, as Sandy River coho are one of only two extant populations in the ESU with appreciable natural production. The LCRFRB (2004) considered Sandy coho to be a primary population for recovery in the Lower Columbia ESU. Primary populations are those that the TRT believe need to be restored to "High" or "Very High" viability levels in order to recover the species. Sandy River coho have been identified (LCRFRB 2004) as needing to be restored to a "Very High" viability level, or >99 percent likelihood of persistence.

The EDT model was used to estimate the benefits for coho salmon that are likely to result from implementing the HCP. Although the model results are not absolute predictions of fish abundance, they do provide a relative comparison of the expected salmon population performance based on the best available science. The inputs to the model represent a combination of site-specific empirical habitat data and, when data were not available, the professional opinion of biologists intimately familiar with the Sandy River ecosystem. See Appendix D for an explanation of the theory and information structure as well as the habitat rating rules for the EDT model.

The EDT model was run for two sets of scenarios: current habitat conditions and the projected future habitat conditions after the City's HCP measures have been implemented. The projections for the VSP parameters were then compared and expressed as an increase (by percentage) in productivity, diversity, and abundance. In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters, but historical spatial processes should be preserved (McElhany et al. 2000). For purposes of the spatial structure analysis, the City determined whether coho distribution would be enhanced in the known primary spawning reaches or whether the current distribution of the species would be increased from the HCP measures. The HCP measures are expected to result in increases in all of the coho salmon VSP parameters.

Increases in productivity, diversity, and abundance for coho are summarized in Table 8-49, below. These estimates represent increases over what could be expected to result from current habitat conditions in the Sandy River Basin. Improvements in spatial structure are discussed below. NMFS (in coordination with ODFW) has not yet developed a recovery plan for the Lower Columbia ESU nor set clear objectives for each VSP parameter; therefore, the significance of these improvements is not yet known.

**Table 8-49. Increases for Coho Expected Due to HCP Implementation[a]**

| | Productivity (%) | Diversity (%) | Productivity (%) |
|---|---|---|---|
| **Without Cedar Creek Weir Removal** | 4 | 16 | 17 |
| **With Cedar Creek Weir Removal** | 4 | 21 | 25 |

Source: EDT model run April 17, 2007
[a]Estimates do not include benefits derived from removing the Marmot Dam on the Sandy River.

### *Productivity*

The estimated 4 percent improvement in coho salmon productivity results from improved rearing and migration conditions in the mainstem Sandy and Salmon rivers. Improved population productivity allows the species to rebound quickly from periods of low ocean or freshwater survival, thereby reducing extinction risk. The 4 percent improvement in productivity increases the probability that the population can maintain abundance levels above those that are deemed viable.

### *Diversity*

The estimated 16 to 21 percent improvement in coho diversity represents improvements in habitat conditions over time and space. Most of this improvement occurs in the lower Sandy River, lower Bull Run, and Cedar Creek. Populations that exhibit a wide range of life histories are more resilient to environmental change.

### *Abundance*

The estimated 17 to 25 percent improvement in coho abundance in the Sandy River Basin results from the increases in productivity and diversity. Increased coho abundance reduces extinction risk for the population. Coho numbers increase as a result of improved migration and rearing conditions in the lower Sandy River, lower Bull Run River, and Cedar Creek.

Higher abundance also results in increased ecological benefits. Salmonids improve both their physical and biological environments through various mechanisms. For example, adult spawners reduce fine sediment concentrations in gravels and their carcasses provide a food source for other aquatic and terrestrial species.

The Interior Columbia River Basin Technical Recovery Team defines viability for Sandy River coho salmon as adult returns exceeding 600 fish (2005). The 17 to 25 percent improvement in coho adult abundance makes a significant contribution toward meeting the minimum viable population abundance value proposed by the LCR-TRT (McElhany, et al. 2000).

### *Spatial Structure*

The viability of a salmon population depends not only on the population's productivity, abundance and diversity, but also on its spatial structure (McElhany et al. 2000). The more watersheds in a basin that contain large numbers of spawners, the less likely catastrophic events such as landslides or human-caused disasters will result in the extinction of the population.

Coho currently spawn and rear in the lower Salmon River and Still Creek, and in the Sandy mainstem between the Salmon and Zigzag river confluences. Historically, coho spawning and rearing occurred in most of the accessible reaches of the Sandy River Basin.

The HCP actions will increase coho distribution in Alder and Cedar creeks. About 18 river miles will be opened for coho usage. That is approximately an 11 percent increase in the current coho distribution for the Sandy River Basin.

The HCP measures are designed to increase fish access, improve riparian condition, increase the amount of large wood, and increase streamflow in one or all of the watersheds inhabited by coho. Removing barriers to coho access in Alder and Cedar creeks and the Little Sandy River will further increase coho abundance and distribution throughout their historic range. The HCP improves spatial structure, as actions are focused on increasing spawner abundance in all of the five watersheds that historically supported coho production. Increased adult abundance in multiple watersheds reduces population exposure to catastrophic events and thus reduces population extinction risk. Table 8-50 summarizes the population effects of the HCP measures on coho by the VSP parameters of abundance, productivity, diversity, and spatial structure.

**Table 8-50. Effects of the HCP Measures on Sandy River Basin Coho Salmon by Viable Salmonid Population (VSP) Parameters**

| VSP Parameter | Reference Condition | Effect of Conservation Measures |
|---|---|---|
| Abundance | Current habitat conditions | Coho abundance for the Sandy River population is projected to increase by 17-25%. |
| Productivity | Current habitat conditions | Productivity for the Sandy River coho population is projected to increase by 4%. |
| Diversity | Current habitat conditions | Diversity for the Sandy River population is projected to increase by 16-21%. |
| Spatial Structure | Current habitat conditions | Spatial structure will improve as actions are focused on increasing spawner abundance in all five of the watersheds that supported coho production historically. Increased adult abundance in multiple watersheds will reduce population exposure to catastrophic events, and thus reduce extinction risk |

Sources: EDT model run April 17, 2007 for abundance, productivity, and diversity percentages; for spatial structure assessment, Kevin Malone, personal comm. 2006

### Summary Comparison of Fish Abundance

The projection of adult coho abundance under the City's HCP is greater than the benchmark comparison scenario established for the Bull Run watershed. This benchmark comparison indicates that the HCP will produce enough beneficial habitat changes for coho to offset all potential impacts that could be caused by the City's water supply operations in the Bull Run.

### Population Effects and Benchmark Comparison of Fish Abundance

The introduction to this HCP chapter describes a benchmark scenario the City developed to compare results of the HCP measures with production potential of the Bull Run watershed (see section 8.1.1). The EDT model was used to generate the estimated abundance of coho salmon and to compare the benchmark against the benefits of the City's HCP measures.

The City believes that the Modified Historical Bull Run Condition estimate represents generous assumptions and the HCP estimate is an underestimate of probable HCP results (see Section 8.1.1).

Model results indicate that the HCP measures would improve habitat sufficiently to match or exceed the production potential of the Modified Historical Bull Run Condition (see Table 8-51).

**Table 8-51. Model Results for Coho Abundance: Modified Historical Bull Run Condition Compared with HCP Measure Implementation[a]**

| Scenario | Adult Abundance |
|---|---|
| Modified Historical Bull Run Condition | 2,551 |
| HCP Measures Without Cedar Creek | 2,842 |
| HCP Measures With Cedar Creek | 3,037 |

Source: EDT model run April 17, 2007

[a]Estimates do not include benefits from removing the Marmot Dam on the Sandy River.

The City believes these results help demonstrate that the HCP will provide the benefits for coho necessary to meet the ESA Section 10 requirements. However, the City does not propose to use EDT population estimates as an enforceable performance measure for coho. The City's HCP is purposefully habitat based. It is designed using measurable objectives, monitoring, and an adaptive management trigger that all relate to habitat condition, as described in other chapters of this document.

### Conclusions about the Habitat Effects of HCP Measure Implementation

- **Effects in the Lower Bull Run River.** All of the HCP measures in the lower Bull Run River will benefit coho. These measures avoid or minimize ongoing City impacts in the Bull Run River (as described in Table 7-1) to the maximum extent practicable. Impacts associated with blocked fish access to the upper watershed and reduced base flows will not be completely addressed in the Bull Run but will be mitigated by offsite measures in the Sandy Basin. Benefits provided by the Bull Run HCP measures are summarized in Table 8-47.
- **Effects in the Sandy River Basin.** Substantial additional benefits for coho are provided by HCP measures in the upper Sandy River and its tributaries (e.g., Salmon and Zigzag rivers), the middle Sandy River, and the lower Sandy River. The upper Sandy has the primary spawning areas and most anchor habitat reaches for coho are upstream of the Marmot Dam site. The primary limiting factor for coho for that area is reduced habitat diversity, side channel habitat, and riparian zone conditions. HCP measure H-18 will improve conditions for coho on the mainstem Sandy River; Measures H-19, H-20, H-21, H-22, H-23, H-24, H-27, H-28, and H-29 will improve habitat in important tributary streams such as the Salmon and Zigzag rivers. For the middle Sandy Basin, measures H-14, H-15, H-16, and H-19 will improve large wood levels, riparian zone conditions, and channel diversity for coho in the mainstem Sandy River and Cedar Creek. HCP measures will also open new habitat for coho in Alder and Cedar creeks. HCP measures in the lower mainstem Sandy (H-11, H-12) will slightly improve habitat for migrating coho juveniles, and measures H-5, H-6, H-7, and H-13 will improve rearing habitat in lower Sandy River tributaries. Benefits provided by the offsite measures are summarized in Tables 8-49 and 8-51 and in Appendix E, Tables E-5 and E-6.
- **Timing for Implementing Measures.** The timing for implementing measures relevant to coho and other species is provided in Tables 7-6 through 7-12. Measures in the upper Sandy River are primarily scheduled for HCP Years 11-15, with some of them occurring in Years 6-10. Most of the measures for coho in the middle Sandy Basin will occur in HCP Years 6-10. The lower Sandy tributary actions and mainstem Sandy easement measures for coho will be implemented in HCP Years 1-5. The City will conduct effectiveness monitoring for the instream measures; the objective in those cases is to accrue 80 percent of the predicted habitat change within 15 years of implementing the measures (see tables in Chapter 9).
- **Population Response.** Although the HCP is not intended to guarantee specific population responses, implementation of the HCP is expected to result in improved population conditions for coho. Table 8-53 describes the anticipated increases of the four VSP parameters: abundance, productivity, diversity, and spatial structure. The estimated population response compared to the Modified Historical Bull Run Condition also indicates that implementation of the HCP will likely result in a population response that is greater than the production potential in the Bull Run watershed. Neither of these estimates includes the habitat or population benefits that will result from the $9 million Habitat Fund.

- **Accumulation of Habitat Benefits.** The HCP conservation measures will accumulate benefits for coho at varying rates. Figure 8-20, which is based on EDT model results, describes the accumulation of benefits over the 50-year HCP term. The figure shows the predicted increase in adult coho abundance that could result from the habitat changes. Benefits are organized according to four general categories of HCP measures: flow, fish passage improvements, instream actions, and riparian easements. The City assumes that the benefits from large wood additions would only contribute to adult coho abundance for the first 15 years of their project life. This is a very conservative assumption because it is likely that the wood will be in the various stream reaches beyond 15 years and adding some habitat value for fish. Other instream actions, such as the opening of side channels and riprap removal, are considered permanent for the purpose of the HCP. Riparian easements are assumed to take 15 years before beginning to provide benefits and would not provide full benefits until 30 years after implementation. Flow measures will provide habitat for coho starting in Year 1 of the HCP, and fish passage improvements for Cedar Creek should start benefiting coho in approximately Year 6.

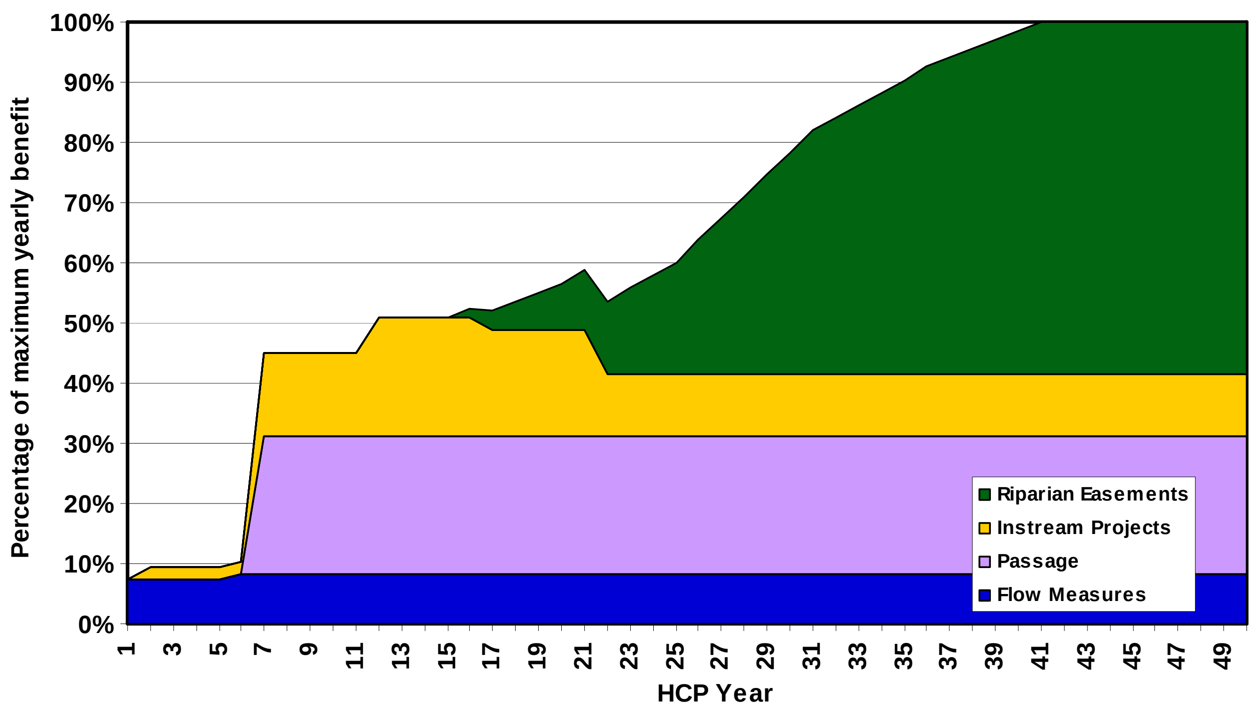


**Figure 8-20. Accumulation of Predicted Benefits to Coho from HCP Measures over Time[a]**

Source: EDT model runs, April 10, 2007.

[a]The accumulated benefits exclude benefits from the following measures: H-3—Little Sandy 1 and 2 LW Placement, P-2—Alder 1 Fish Passage, P-3—Alder 1A Fish Passage, H-25—Salmon 2 Carcass Placement, H-29—Zigzag 1A, 1B, and 1C Carcass Placement

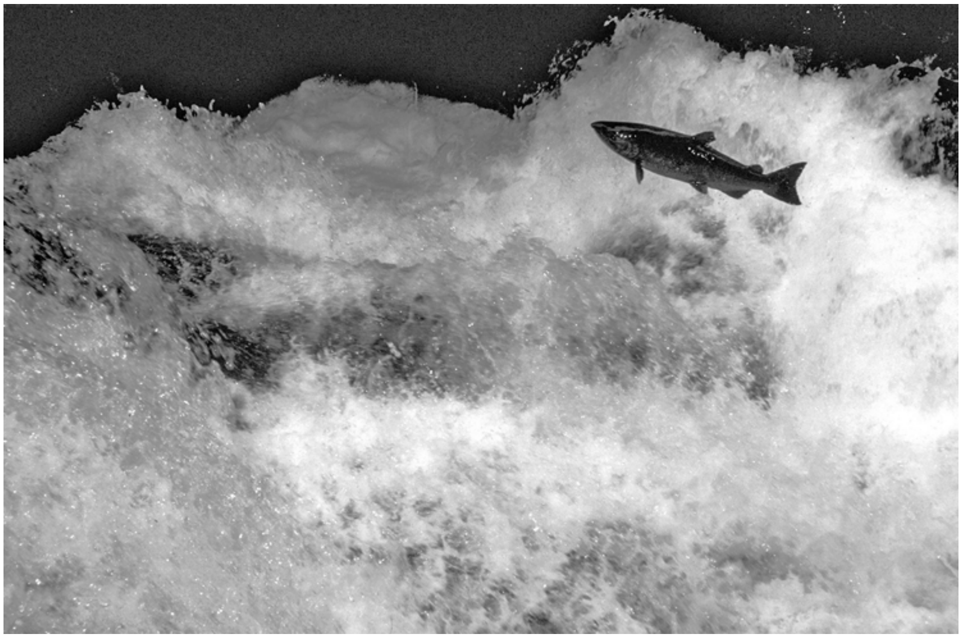

Photo courtesy of Bonneville Power Administration.

The full coho benefits would be realized by approximately HCP Year 40. This maximum benefit level closely corresponds to the abundance number used in Table 8-49 for the "HCP Measures with Cedar Creek" scenario, but the benefit level excludes the benefits of large wood additions. Through the term of the HCP, the cumulative total benefits will be 12 percent from the flow measures, 17 percent from instream measures, 40 percent from riparian easements, and 30 percent from the Cedar Creek fish passage improvements.

**The City believes the HCP, as a whole, meets ESA Section 10 requirements for coho.**

## 8.3 Other Covered Fish Species

The City is requesting ESA coverage for chum salmon and eulachon in addition to the four primary species discussed above. Less information is available about these species, but the same types of effects are described:

- Effects on habitat from Bull Run operations and HCP measures in the lower Bull Run River
- Effects on habitat in the Columbia River
- Effects on habitat in Sandy River Basin Watersheds from the HCP offsite measures
- Estimated effects of the HCP measures on the Sandy River populations, expressed in terms of VSP parameters

### 8.3.1 Chum Salmon

**Effects on Habitat in the Lower Bull Run River**

The City does not believe that the Bull Run watershed was utilized historically by chum salmon. Therefore, the City's water supply operations do not negatively affect chum salmon habitat. Only the offsite HCP measures implemented in other reaches of the Sandy River Basin will have an effect on habitat that chum salmon may have once used.

**Effects on Habitat in the Columbia River**

Chum salmon spawn and rear in the lower Columbia River. Two focal points for spawning are located just upstream of the I-205 bridge (Wood's Landing and Rivershore development). Both sites are associated with shallow groundwater discharges into the river. The Wood's Landing groundwater emerges from a series of springs. The Rivershore groundwater originates in a nearby creek and emerges as hyporheic flow (Rawding and Hillson 2002). The groundwater used by the City for water supply (near the I-205 bridge) is from deeper aquifers approximately 300-500 feet below ground surface (e.g., the Troutdale Sandstone Aquifer and the Sand and Gravel Aquifer). These groundwater sources are not directly connected to the shallow groundwater at Wood's Landing or Rivershore. The City's use of groundwater will have no effect on chum salmon spawning in the Columbia River nor will it affect migrating chum in the Columbia River (see the analysis of the effects of groundwater use on Columbia River flows in Section 8.2).

**Effects on Habitat from the HCP Offsite Measures**

Specific information on habitat utilization for chum salmon in the Sandy River Basin is extremely scarce. Because chum salmon and fall Chinook have similar timing for adult spawning and juvenile habitat preferences, the City assumes that habitat preferences for chum would be similar to those for fall Chinook salmon.

Historically, it is believed that chum salmon used the low-gradient mainstem Sandy River reaches below the gorge that starts at Revenue Bridge (RM 24) (Kostow, ODFW, pers.

comm., 2005) and the lower end of Beaver Creek (Mattson 1955). The City has planned measures along the mainstem Sandy River reaches, both upstream and downstream of the confluence with the Bull Run River, which should improve habitat for chum.

Six specific offsite conservation measures will be implemented in the mainstem middle and lower Sandy River reaches (from the mouth of the river to Revenue Bridge) that should improve habitat conditions for chum salmon. The effects of these measures are summarized in Tables 8-6 and 8-7 in the discussion of offsite habitat effects for fall Chinook (Section 8.2.1). The measures include riparian easements, placement of large wood, and opening the historical mouth of the Sandy River and other side-channel areas.

The conservation measures in the mainstem Sandy River reaches will improve several habitat parameters for chum salmon. The riparian easements, engineered log jams, and large wood will improve habitat conditions over existing conditions in the lower Sandy River. The channel reconnection will improve fish access and reopen approximately one mile of new habitat. This additional side-channel habitat will provide low-velocity rearing habitat for chum and other salmonids.

#### Population Effects and VSP Parameters

The effects of the City's habitat measures on chum salmon were not modeled. It is assumed that the benefits to this species would be similar to those described previously for fall Chinook. For fall Chinook, the HCP measures are expected to produce increases in the abundance, productivity, and diversity for the Sandy River population (see Population Effects and VSP Parameters section for fall Chinook). The City assumes that chum will benefit similarly from the conservation measures. For spatial structure, the HCP measures will not increase the distribution of chum salmon in the Sandy River Basin. However, habitat conditions in the lower portions of the mainstem Sandy River will improve and that should benefit chum.

#### Conclusions About the Habitat Effects of HCP Measure Implementation

The City believes that chum did not historically use lower Bull Run River habitat but did use the lower Sandy River. The benefits that accrue to chum as a result of implementation of this HCP are similar to the benefits for fall Chinook in the lower mainstem Sandy River.

Collectively, the City's HCP conservation measures in the mainstem Sandy River reaches should improve conditions and have a positive effect on chum habitat in the lower Sandy River watershed.

### 8.3.2 Eulachon

**Effects on Habitat in the Lower Bull Run River**

The lower Bull Run River was not used historically (and is not currently used) by eulachon. Therefore, the City's water supply operations do not negatively affect eulachon habitat. Only the offsite HCP measures implemented in other reaches of the Sandy River Basin will have an effect on habitat that eulachon may use.

**Effects on Habitat in the Columbia River**

Eulachon spawn in the Cowlitz River and the lower mainstem of the Columbia River from RM 25 to immediately downstream of Bonneville Dam. Periodic spawning also occurs in tributaries such as the Sandy River. The City's use of groundwater will have no effect on eulachon spawning in the Columbia River or on eulachon movements in the Columbia River.

**Effects on Habitat from the HCP Offsite Measures**

Specific information on habitat utilization for eulachon in the Sandy River Basin is not available. Eulachon have been observed in the first few miles of the Sandy River, perhaps up to the lower end of Beaver Creek. Spawning substrates range from silt, sand, or gravel to cobble and detritus. Spawning rivers may be turbid or clear.

The City has planned measures along the mainstem Sandy River reaches that should improve habitat for eulachon. The measures include riparian easements, placement of large wood, and opening the historical mouth of the Sandy River and other side-channel areas. These measures will increase habitat complexity and provide approximately one mile of new habitat. The additional side-channel habitat will provide low-velocity spawning habitat. The effects of these measures are summarized in Tables 8-6 and 8-7 in the discussion of offsite habitat effects for fall Chinook.

**Population Effects and VSP Parameters**

The effects of the City's habitat measures on eulachon were not modeled, and very little information is available about the population parameters for this species. The City assumes that eulachon will benefit from the habitat improvements, but too little is known about their habitat needs to quantify this relationship.

**Conclusions About the Habitat Effects of HCP Measure Implementation**

The City believes that eulachon will not be affected from measures in the Bull Run River, but will benefit from measures in the lower Sandy River Basin because of the improvements to habitat conditions.

## 8.4 Other Fish Species Addressed by the HCP

This HCP addresses five fish species in addition to the covered fish species: rainbow trout, cutthroat trout, Pacific lamprey, western brook lamprey, and river lamprey. Where possible, the description of effects for each of these fish species follows a pattern similar to that for the four primary covered species:

- Effects on habitat from Bull Run operations and HCP measures in the lower Bull Run River (or Bull Run reservoirs)
- Effects on habitat from Bull Run operations and HCP measures in the lower Sandy River
- Effects on habitat in the Columbia River
- Effects on habitat in Sandy River Basin watersheds from the HCP offsite measures
- Estimated effects of the HCP measures on the Sandy River populations, expressed in terms of VSP parameters

The information available for these species varies, therefore the habitat effects descriptions also vary in length.

### 8.4.1 Rainbow Trout

Table 8-52 summarizes the historical distribution of rainbow trout in the Bull Run watershed.

**Table 8-52. Historical Distribution of Rainbow Trout in the Bull Run River**

| River Segment | River Miles |
|---|---|
| *Lower Bull Run River* | |
| Bull Run River (mouth to Dam 2 spillway weir) | 5.8 |
| Walker Creek | 0.15 |
| Little Sandy River (mouth to Little Sandy Dam) | 1.7 |
| Little Sandy River (Little Sandy Dam to middle waterfalls) | 5.6 |
| Little Sandy River Tributaries (upstream of Little Sandy Dam) | 2.0 (est.) |
| *Upper Bull Run River* | |
| Bull Run River (Dam 2 spillway weir up through reservoirs) | 9.2 |
| Bull Run River (free-flowing river to waterfall at RM 16.3) | 1.3 |
| South Fork Bull Run River | 2.7 |
| Cedar Creek (tributary to South Fork Bull Run River) | 8.1 |

**Table 8-52. Historical Distribution of Rainbow Trout in the Bull Run River, continued**

| River Segment | River Miles |
|---|---|
| Bull Run River (RM 16.3 to 80' waterfall) | 5.4 |
| Camp Creek | 0.6 |
| Fir Creek | 0.5 |
| Bear Creek | 0.3 |
| Cougar Creek | 0.7 |
| Deer Creek | 0.5 |
| North Fork Bull Run River | 0.8 |
| Log Creek | 0.2 |
| Falls Creek | 0.8 |
| West Branch Falls Creek | 0.3 |
| Blazed Alder Creek | 2.4 |
| Blazed Alder Tributaries | 0.4 (est.) |

Source: USFS, 1999

Rainbow trout are now present year-round in Reservoir 1. Cutthroat trout and cutthroat/rainbow hybrids are also present in Reservoir 1. Rainbow trout have not been found in Reservoir 2.

### Effects on Habitat in the Lower Bull Run River

Rainbow trout and steelhead are the same species, and the City assumes that the HCP effects on rainbow in the lower Bull Run River would be much the same as for steelhead.

### Effects on Habitat in the Bull Run Reservoirs

The City will operate the reservoirs during the term of the HCP in a manner expected to minimize impacts to rainbow trout (see Measure R-1 – Reservoir Operations). Operating the City's water system could have four types of effects on resident rainbow trout in Reservoir 1:

1. Access to reservoir tributary streams for spring spawning
2. Reservoir water quality
3. Entrainment through the water intakes in Reservoir 1
4. Ramping rates downstream of the Dam 1 powerhouse

Each of the four types of effects is described below.

### *Access to Reservoir Tributary Streams*

The City conducted a survey of the margins of both reservoirs in the spring during the peak rainbow and cutthroat trout spawning period in 2003. The survey results indicated that access to the tributary streams was easily available when reservoir water level elevations were within a few feet of full-pool elevations (full-pool elevations for Reservoirs 1 and 2 are 1,045 feet and 860 feet, respectively).[14] Only Deer Creek on Reservoir 1 could be blocked for fish access when the reservoir elevation decreases below 1,042 feet. Since the City always fills Reservoir 1 in the spring, rainbow trout will be able to access the spawning tributaries. Reservoir 1 will be operated to reach full-pool levels every spring, so future operations will ensure access to reservoir tributaries for spawning rainbow trout.

### *Reservoir Water Quality*

The City conducted a study in 2001 comparing water temperature and dissolved oxygen conditions throughout the depths of the reservoirs with conditions in 1996 (Beak 2001a). Water quality conditions in the reservoirs in 1996 were used as the reference condition because these conditions represent the approximate time period when fish were placed on the Endangered Species list, and are indicative of whether reservoir habitat was limiting fish production.

The study results indicated that Reservoir 1 undergoes thermal stratification as the year progresses from early spring into summer. The water temperatures are within the suitable range for rainbow trout and other salmonids throughout the year. An additional study of fish growth and feeding in Reservoirs 1 and 2 concluded that trout growth was excellent and that food availability did not appear to be a limiting factor (Beak 2001b).

The vertical dissolved oxygen profiles show the potential effects of operating the water system. The study indicated that dissolved oxygen concentration in Reservoir 1 was well mixed in the early spring and began to drop as the season progressed and reservoir temperatures began to rise (Beak 2001a). Figure 8-21 shows that dissolved oxygen levels in both reservoirs are within the suitable range for salmonids throughout the year.

Environmental Protection Agency (EPA) research on dissolved oxygen requirements for six salmonid species shows that the influence of dissolved oxygen on growth is negligible above 7 milligrams per liter (mg/L). EPA proposed 7- and 30-day mean criteria of 5 and 6.5 mg/L, respectively, for protecting other than early life stages and suggested an 8 mg/L threshold as the 30-day mean criterion to protect juvenile/adult life stages as well as developmental stages (1986). ODEQ has established a state standard that dissolved oxygen may not be less than 8 mg/L for waters with cold-water aquatic life (OAR 340-041-0019).

Dissolved oxygen may not fall below 8 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day mean minimum, and 6 mg/L as an absolute minimum (OAR 340-041-0019). Figure 8-21 shows that dissolved oxygen in the Bull Run reservoirs exceeds 8 mg/L throughout the water column of both reservoirs except in August–September. Even during this period, dissolved oxygen exceeds 8 mg/L in about the top 5 meters (approximately 16 feet) of the water column and exceeds 6 mg/L in all but about the middle 20 percent of the water column.

[14] In about 15 percent of years, unusually dry spring conditions may cause reservoir drawdown to begin in late May. However, the City expects to maintain water levels at or just below full-pool elevations until mid-May in all years, including the 15 percent of years with unusually dry spring conditions.

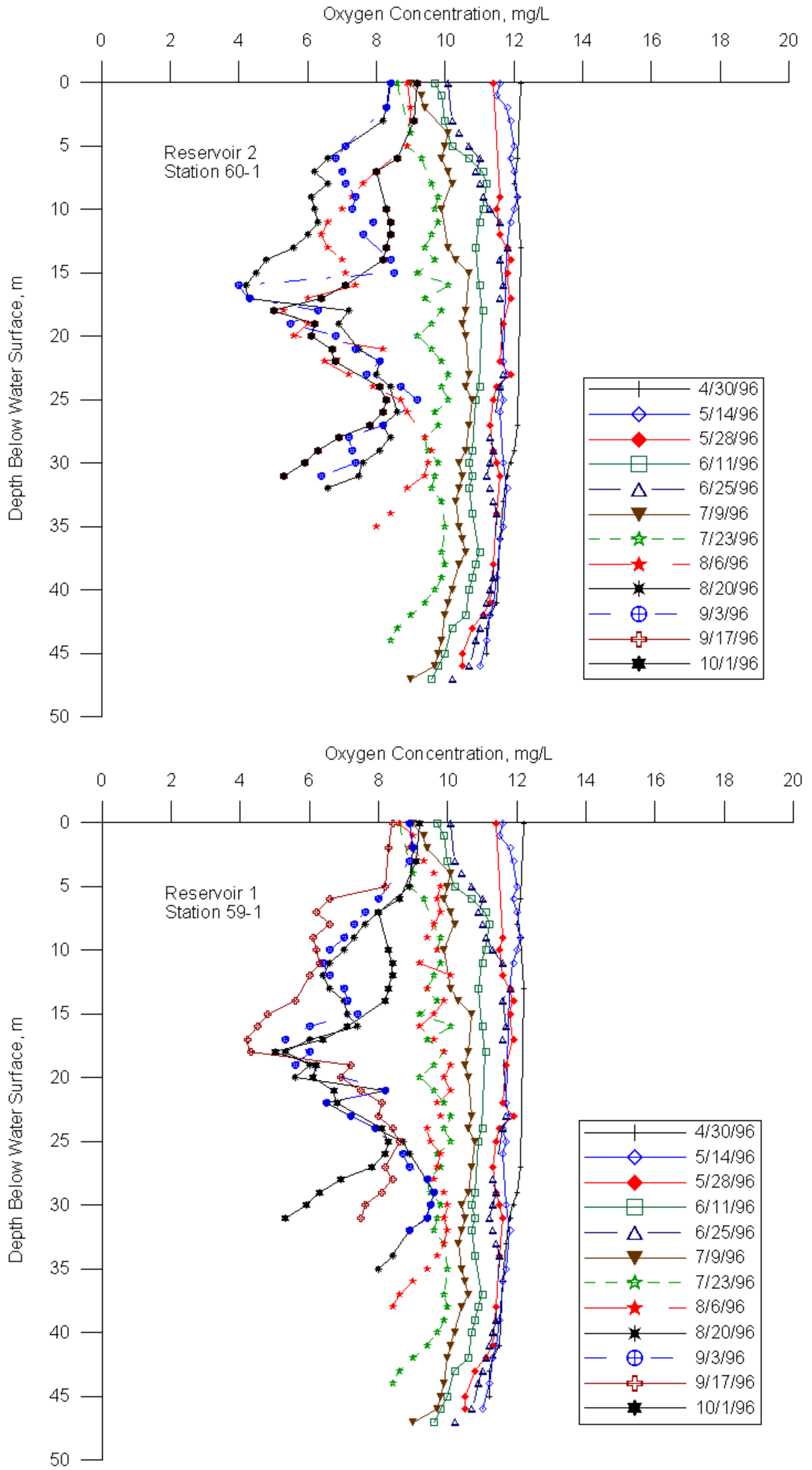


**Figure 8-21. Vertical Dissolved Oxygen Profiles for Reservoirs 1 and 2**

Source: Beak 2001a

Overall, the City's continuing operations in the Bull Run River are likely to have minimal effects on the water quality of the reservoirs. Water temperatures and dissolved oxygen levels present in the reservoirs will continue to support populations of rainbow trout.

***Entrainment at the Water Intakes***

Rainbow trout are in Reservoir 1 and the City does not have fish screens on its water intake structures that meet current fish screening criteria. However, the City believes that entrainment of rainbow trout in Reservoir 1 is very low, and it is not negatively affecting the reservoir population of fish. That conclusion is based on the following:

1. The rainbow trout in Reservoir 1 no longer would demonstrate strong anadromous or fluvial life-history patterns because they have been isolated in the upper Bull Run watershed for a long time.

   All anadromous fish were blocked from the upper Bull Run River in 1921 from construction of the diversion dam on City property at RM 6.0. Construction of Reservoir 1 in the 1920s further isolated the rainbow trout. Because the trout have been isolated for over 80 years in the upper Bull Run, it is unlikely that there would be significant numbers of fish trying to smolt and migrate downstream, so entrainment rates at Dam 1 would be related to random encounters of fish at the water intakes.

2. Rainbow trout do not concentrate near the Dam 1 water intakes.

   The City conducted a hydroacoustic survey in 1999 (HTI 2000), and the fish were distributed significantly away from the dam, even though the reservoir was drawn way down for water supply reasons. The City applied a chi-square statistical test and determined that fish density was much lower next to the dam and water intakes.

3. Only larger rainbow trout would randomly encounter the Dam 1 intakes and they are less susceptible to entrainment.

   Adfluvial rainbow and cutthroat trout tend to remain in their natal tributaries for the first year or two (Quinn 2005, Trotter 1989, Nowak et al. 2004). All natal tributaries are located a significant distance from the Dam 1 water intakes. Fry and juveniles in lakes tend to be associated with the banks where they can find cover (Tabor and Wurtzbaugh 1999, Bozek and Rahel 1991). Small fish that venture into open water probably would experience a high risk of predation before they reach the water intakes because of the adult rainbow and cutthroat trout's piscivorous behavior (Nowak et. al. 2004). For these reasons, the City does not believe that small rainbow would likely encounter the water intakes and be entrained. Larger fish, which could randomly encounter the intakes, would be better able to resist the approach velocities at the intake gates.

4. The City's operational protocols for running water though the Dam 1 water intakes will minimize the potential entrainment of rainbow trout.

   The City does not run the Reservoir 1 hydroelectric powerhouse continuously, and that dictates the amount of water that is pulled from the reservoir. During the summer when the reservoir is drawn down, powerhouse use occurs primarily in the

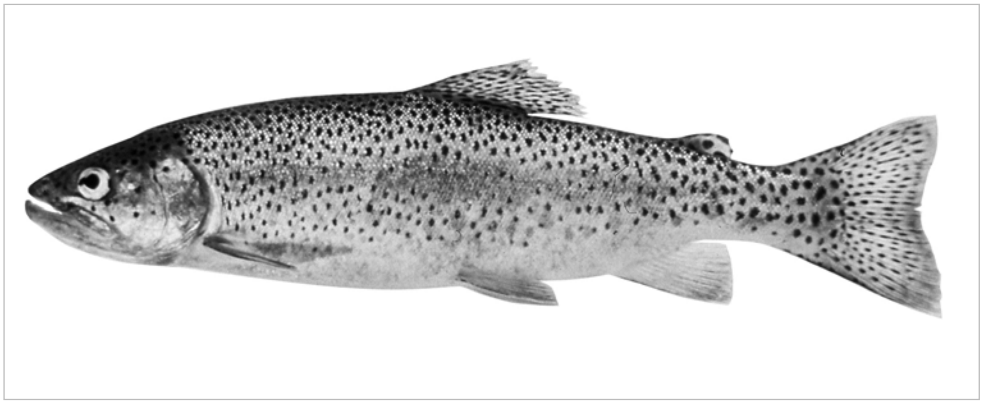

**Photo courtesy of Bonneville Power Administration**

morning and evening to keep the reservoir elevation within a target range. When reservoir inflows are low, the powerhouse tends to be operated only once per day for a few hours.

The City believes that entrainment is not significantly affecting the rainbow or cutthroat trout in Reservoir 1.

*Ramping Rates Downstream of Dam 1*

The City believes that few fish, if any, are stranded due to hydropower generation from the Dam 1 powerhouse. Dam 1 is at the upper end of Reservoir 2, which is approximately 4.5 miles long. Over the entire length of the reservoir, only about 1,000 feet of riverine habitat is not inundated, less than 5 percent of the lineal distance between the dams. This is the only area where trout stranding could occur as a result of hydropower operations.

A hydroacoustic survey of Reservoir 2 (HTI 2000) showed that rainbow (and cutthroat) trout are distributed throughout the lineal distance of the reservoir and are not concentrated in the upper end where there could be stranding effects. Also, the City's hydropower operations can only lower the top two feet of Reservoir 2, which restricts the area affected by downramping in the upper portion of Reservoir 2. Based on the small amount of habitat in which fish could be stranded and the 2"/ hour restriction for lowering the reservoir elevation, continued hydropower operations at Dam 1 are not likely to negatively affect the population of rainbow trout in Reservoir 2.

## Conclusions about the Habitat Effects of HCP Measure Implementation

The City assumes that the effects on habitat from the HCP offsite measures for rainbow trout would be the same as those for steelhead which are discussed in Section 8.2.3. Conclusions regarding the habitat effects of implementing the HCP for winter steelhead are listed on page 8-114.

The HCP is expected to result in both short- and long-term benefits to rainbow trout. All of the HCP measures in the lower Bull Run River and the Bull Run reservoirs will benefit rainbow trout. Substantial additional benefits for rainbow trout are provided by HCP measures in the upper Sandy River and its tributaries. The City also assumes that the Sandy

River rainbow population will benefit by the HCP measures since all VSP parameters will increase for steelhead.

With the additional benefits that will accrue above and beyond the core HCP measures, the City considers the HCP as a whole package to be more than adequate to compensate for impacts to rainbow trout in the Bull Run watershed.

### 8.4.2 Cutthroat Trout

Coastal cutthroat trout have habitat preferences that overlap both those of steelhead and rainbow trout, and also those of coho salmon (Trotter 1989). In streams where cutthroat, rainbow, and steelhead occur, cutthroat trout tend to dominate in relative numbers in higher elevation portions of streams, while steelhead and rainbow dominate in lower portions of the same streams (Nicolas 1978, Campton and Utter 1985). This appears, however, to be attributable to partitioning of spawning reaches, not a difference in habitat requirements (Campton and Utter 1985). Cutthroat trout and steelhead in the Sandy River both spawn from February through May, depending on temperature and location in the watershed, and emerge from April through July (Figure 8-11). Because of their intermediate adaptations, cutthroat trout tend to be displaced from pool habitats by coho and from swifter water habitats by steelhead (Bisson et al. 1988). In lakes, populations of cutthroat and rainbow trout living in isolation from one another both make broad, overlapping use of resources and space, but partition both when they live together (Nilsson and Northcote 1981). Steelhead and cutthroat trout were also found to respond similarly to habitat alterations in Oregon coastal streams (Solazzi et al. 2000).

Although there is almost no specific information on cutthroat trout in the Sandy River, this effects analysis assumes that cutthroat trout prefer habitat conditions that are completely overlapped by those preferred by coho and especially steelhead and rainbow trout, as described above. For the cutthroat trout effects analysis, the City examined habitat information specific for the species. When information was not available, effects were inferred from analogous analyses for steelhead or coho salmon.

#### Effects on Habitat in the Lower Bull Run River

The key habitat metrics for cutthroat trout in the lower Bull Run River include streamflow, water temperature, large wood, spawning gravel, access, riparian function, and total dissolved gases.

*Streamflow*

The City analyzed streamflow effects on cutthroat trout by two means: comparing the effects of the HCP Bull Run base flows with the natural (pre-water-system) conditions and by determining the cutthroat spawning and rearing WUA likely to result from Bull Run flow measures.

**Bull Run Base Flows.** The City compared an estimate of median monthly flows (50 percent exceedance flows) under natural conditions (i.e., no dams or diversions in the Bull Runwatershed) with anticipated future flows during implementation of the HCP, assuming normal and critical years occur at the same frequency in the Bull Run as they have in the past. A 64-year hydrological record (1940–2004) was used for the analysis. The estimated median natural and HCP flows for the Bull Run River upstream of the Little Sandy River are shown in Figure 8-22, with peak periods of life-stage occurrence, as documented in the periodicity chart in Chapter 5 (Figure 5-41) and Figure 8-22 below. All flow amounts are relative to the USGS Gauge No. 14140000 located at RM 4.7 on the Bull Run River.

Table 8-56 shows the median natural flows and median flows anticipated from implementing the HCP. The comparison is for flows in two segments: upstream of the confluence with the Little Sandy River (RM 3.0—RM 5.8), and downstream of the Little Sandy River (RM 0–RM 3.0). For the portion of the Bull Run River downstream of the Little Sandy River, median flows were determined using the estimated Little Sandy median natural flows that would occur after the Little Sandy Dam is removed.[15]

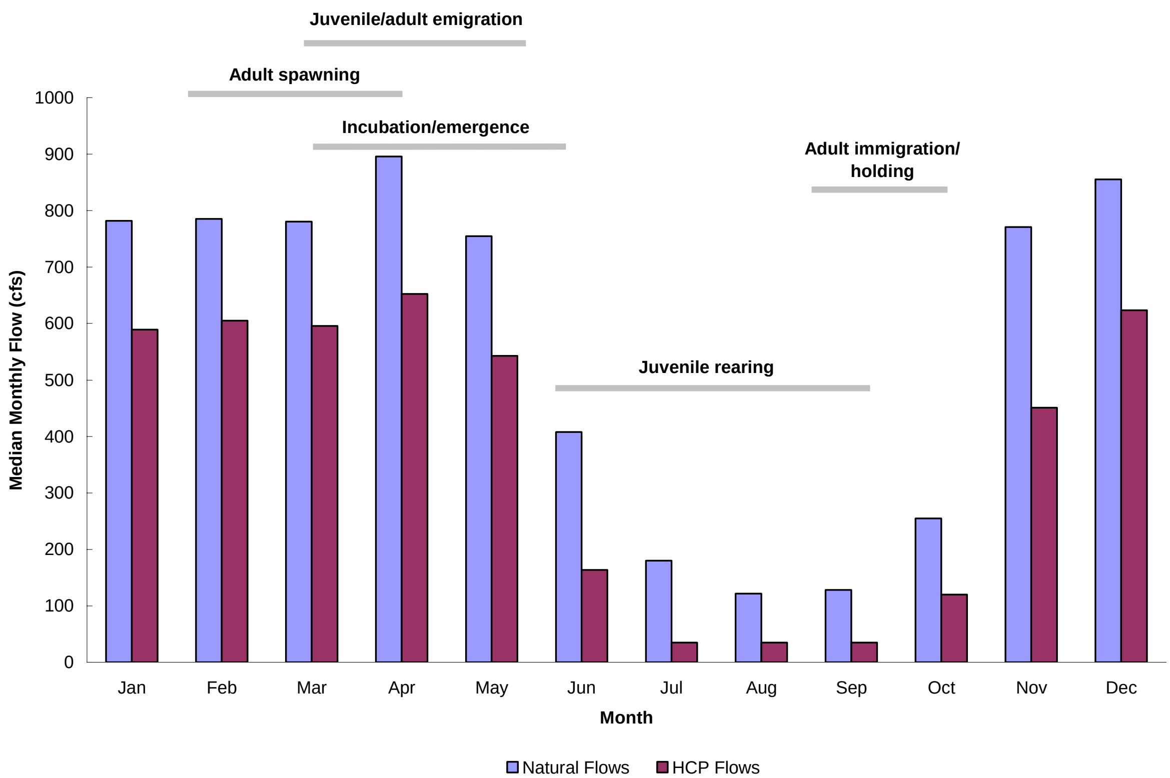


**Figure 8-22. Median Monthly Flows and Peak Periods of Occurrence for Cutthroat Trout in the Lower Bull Run River above the Little Sandy River Confluence[a]**

Source: Median monthly flows for the upper reach of the Lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000 (RM 4.7).

[a]Although peak juvenile rearing period is shown here, cutthroat trout rearing occurs all year. See Figure 5-32 for periods of occurrence in the lower Bull Run River.

[15] See Section 4.1.5 Water Quality and Water Rights for more information about the removal of the Little Sandy Dam.

**Table 8-53. Natural and HCP Median Flows by Month for the Lower Bull Run River**

| | Above Little Sandy River | | Below Little Sandy River | |
|---|---|---|---|---|
| **Month** | **Natural (cfs)** | **HCP (cfs)** | **Natural (cfs)** | **HCP (cfs)** |
| **January** | 782 | 611 | 938 | 765 |
| **February** | 785 | 608 | 957 | 776 |
| **March** | 780 | 606 | 932 | 760 |
| **April** | 896 | 672 | 1,072 | 846 |
| **May** | 755 | 563 | 898 | 709 |
| **June** | 408 | 196 | 487 | 274 |
| **July** | 180 | 35 | 213 | 67 |
| **August** | 122 | 35 | 141 | 54 |
| **September** | 128 | 35 | 152 | 55 |
| **October** | 255 | 120 | 304 | 166 |
| **November** | 771 | 427 | 924 | 608 |
| **December** | 857 | 654 | 1,031 | 829 |

[a]Median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS Gauge No. 14140000, Bull Run River (RM 4.7).

[b]The sum of median monthly flows for the upper reach of the lower Bull Run River (1940–2004) taken at USGS gauge 14140000, Bull Run River (RM 4.7) and median monthly flows taken at USGS Gauge No. 14141500, Little Sandy River (RM 1.95).

**Effects of Flows on Spawning.** The peak spawning period for coastal cutthroat trout in Oregon streams is February (Trotter 1989). During the winter and spring period, the City's HCP flows, with a minimum flow of 120 cfs, would support cutthroat trout spawning, egg incubation, and fry emergence.

Upstream of the Little Sandy confluence, the City's HCP flows from January to May will be 23 percent lower than the median natural flow. Downstream of the Little Sandy River, the City's HCP flows will be 19 percent lower than the proposed flow. Even with the difference between the natural flows and the HCP flows, there will be a minimal effect on cutthroat spawning, egg incubation, and fry emergence. Based on WUA results for steelhead/rainbow trout discussed in Section 8.2.3, near-optimal habitat conditions for spawning steelhead were predicted to occur between flows of 130 and 200 cfs (R2 Resource Consultants 1998). These flows levels are also thought to be protective of cutthroat trout.

Coastal cutthroat trout, like steelhead/rainbow trout, can spend several years rearing in fresh water before smolting. Most emigrate at ages 2, 3, and 4 (Trotter 1989). The cutthroat summer rearing period is June through September. For the cutthroat rearing period in the Bull Run River above the confluence with the Little Sandy River, the projected HCP flows are 64 percent lower than the natural flows. Downstream of the Little Sandy River, the projected HCP flows are 54 percent lower than the natural flows. The significance of flow differences for cutthroat trout is further discussed by referring to WUA for rearing steelhead/rainbow in the following subsection.

**Bull Run Weighted Usable Area.** WUA values do not exist for cutthroat trout in the Sandy River Basin. For this analysis, the City assumed that the impacts to steelhead/rainbow trout WUA values would be applicable to cutthroat because the species have very similar life history traits and habitat preferences. WUA values were calculated for steelhead/rainbow trout spawning and rearing to assess the effect of the HCP flow measures on lower Bull Run River habitat. Table 8-28 compares WUA estimates for natural flow conditions (no dams and no diversions) and for HCP flows, upstream and downstream of the Little Sandy River. Median flows were used to generate the WUA estimates.

R2 Resource Consultants (1998) estimated the habitat-flow relationships for steelhead/rainbow trout spawning and rearing in the Bull Run River. Using the PHABSIM model, they generated estimates of WUA for up to 500 cfs for four segments of the Bull Run River. The four segments were combined into the two segments of the lower Bull Run River: upstream and downstream of the Little Sandy River. For flows greater than 500 cfs, goodness-of-fit curves were used to extrapolate WUA values.

The WUA estimates for natural and HCP flows are compared using a "percentage of natural" metric. For example, if the HCP percentage of natural flow is 90 percent and the natural WUA value is 1.0 acre in a particular month, the HCP median flow will yield a WUA value of 0.9 acre in that month.

Cutthroat trout spawn from late winter through spring, depending on the life history type and water temperature. The WUA analysis for steelhead/rainbow spawning conditions supports the assertion that the City's minimum flows are protective of cutthroat trout. The City's minimum flow of 120 cfs from December 1 through June 15 will maintain optimal spawning and incubation conditions for steelhead/rainbow, which are projected for cutthroat as well.

WUA values for steelhead/rainbow were used to determine the potential HCP effects on rearing cutthroat in the lower Bull Run River from June through September. R2 Resource Consultants estimated that habitat area (WUA) for steelhead/rainbow trout increases at a rapid rate between 0 and 100 cfs, with the most rapid increase occurring between 0 and 20 cfs (R2 Resource Consultants 1998). With HCP flows, the WUA values range from approximately 70 to 100 percent of natural flow WUA values for June through September. The HCP flows would have a small effect on rearing habitat conditions for cutthroat trout in the lower Bull Run River.

**Downramping Rates.** The City has studied juvenile salmonid stranding during different downramping events in the lower Bull Run River (Beak Consultants 1999; CH2M HILL 2002). The sites selected for monitoring included the widest areas of the channel considered most sensitive to downramping effects and stranding. Rainbow trout fry (about 40 mm average length) and yearlings (Age-1) juveniles were observed during the studies. Based on the studies, a ramping rate of no more than 2"/hour was recommended for the lower Bull Run River. This rate is generally what the state of Oregon and others have recommended to protect against juvenile fish stranding (CH2M HILL 2002; Hunter 1992).

The City will avoid or minimize the risk of fish stranding by maintaining a maximum downramping rate of 2"/hour year-round. Not all effects from flow downramping can be avoided, however, due to certain circumstances beyond the control of the City. These circumstances include natural storm flows beyond the City's control, mechanical/control system failures that are impossible for the City to predict, and FERC mandatory testing of project safety equipment. The City did a year-long evaluation (Galida 2005) and determined that these conditions occurred less than 1 percent of the time, which will have minimum effects on cutthroat.

**Little Sandy River Base Flows.** Forgoing development of the City's water rights on the Little Sandy River for the term of the HCP will help assure unimpeded natural flows on the Little Sandy River for cutthroat trout. Cutthroat trout will have access to approximately 7.3 river miles of the mainstem Little Sandy and 2 miles of tributary habitat. This measure will significantly increase the spawning and rearing habitat for coastal cutthroat trout.

### *Water Temperature*

Cutthroat utilize the lower Bull Run River watershed most of the year, with peak periods for spawning, incubation, and emergence from February through July. After infrastructure changes to the Bull Run are completed, the HCP flow and temperature management measures will closely approximate the natural water temperature regime (Figure 8-23).

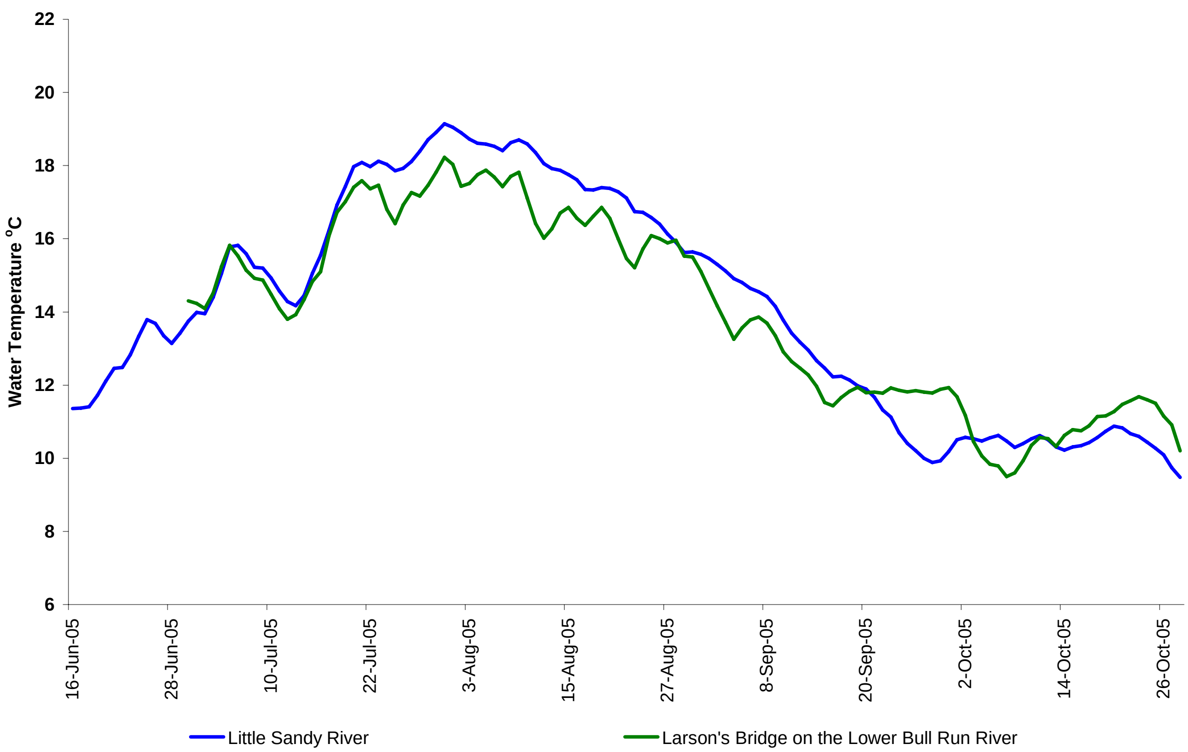


**Figure 8-23. Comparison of Actual 7-Day Maximum Water Temperatures for the Little Sandy with Predicted 7-Day Maximum Average Temperatures Lower Bull Run River, June 16–October 24, 2005**

Source: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8) and CE-QUAL-W2 Modeled Temperatures (February 2006)

**Diurnal Water Temperature Fluctuations.** Diurnal water temperature fluctuations likely to result from implementing the HCP measures were estimated using modeling results and measured Little Sandy River water temperatures. Table 8-54 lists observed and expected temperature fluctuations for the summer and late summer months. These are the months when the City's implementation of the water temperature measure (Measures T-1 and T-2) will affect diurnal temperature fluctuations. The fluctuations expected after implementing the HCP measures are predicted to be smaller than the fluctuations that would occur under natural conditions.

**Table 8-54. Diurnal Water Temperature Fluctuations (°C)**

| Month | Bull Run Observed (current conditions) | Little Sandy Observed (natural conditions) | Expected HCP |
|---|---|---|---|
| June | 4-6 | 0.5-5 | 2-3 |
| July | 4-6 | 1-5 | 2-3 |
| August | 3-5 | 1-5 | 2-3 |
| September | 2-3 | 1-4 | 1-2 |

Source: Bull Run observed temperatures: USGS Gauge No. 14140000 on the Bull Run River (RM 4.7); Little Sandy observed temperatures: USGS Gauge No. 14141500 on the Little Sandy River (RM 3.8); expected HCP temperatures: CE-QUAL-W2 Modeled Temperatures (February 2006).

The City reviewed available research on the influence of fluctuating water temperature on the growth of salmonids. Experiments on steelhead and coho (Hahn 1977; Grabowski 1973; and Thomas et al. 1986) indicated that fluctuating water temperature tests and the constant test exposures produced equivalent results. The City concludes that the reductions in diurnal water temperature fluctuations will not affect cutthroat trout or other salmonids that utilize the lower Bull Run River.

### *Large Wood*

Large wood is removed from the upper end of Reservoir 1 to protect the downstream water supply dams from damage. The USFS owns this wood because it is transported by tributaries from national forest land. Since this wood is not allowed to travel down the lower Bull Run River, a small amount of beneficial habitat for cutthroat trout is potentially lost. The lower Bull Run is, however, a high-order confined stream and is not likely to trap and store large wood. Photographs taken of the lower Bull Run in the late 1890s, before the dams and water diversions were constructed, show little large wood in the channel. The lower river is probably a transport reach for large wood.

The lower Bull Run River is dominated by bedrock and boulders. This channel roughness supports diverse habitats, including about 27 percent pool habitat. The presence of this pool habitat suggests that large wood is not an important requirement of pool formation, and the addition of large wood would provide only a minor increase in pool habitat.

Historically, large wood pieces may have helped trap suitable spawning gravel and form some low-velocity areas that juvenile steelhead/rainbow trout may have utilized during

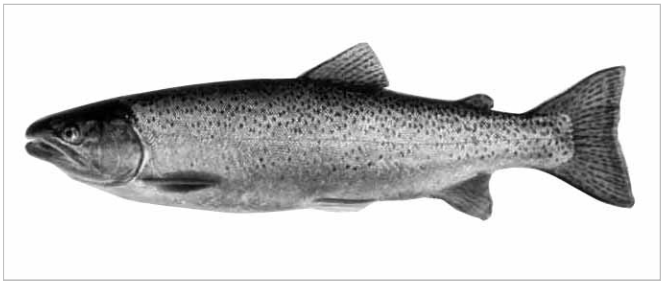

Photo courtesy of
Bonneville Power Administration

winter months. Cutthroat trout also use off-channel pools and side channels as winter habitat (Bustard and Narver 1975, Sedell et al. 1984, Hartman and Brown 1987).

The City does not plan to artificially place large wood in the lower Bull Run River above Larson's Bridge because of concerns about the vulnerability of water supply infrastructure (i.e., conduit trestles). The City will let natural recruitment of large wood occur downstream of Larson's Bridge. Trees that fall naturally will be left in place to modify the stream channel as long as the water conduits and bridges are not threatened.

#### *Spawning Gravel*

The two Bull Run dams interrupt bedload and gravel movement to the lower Bull Run River, resulting in reduced spawning habitat for steelhead/rainbow trout. The estimated historical gravel supply rate was roughly 30—1,000 cubic yards (CH2M HILL 2003b). The City will place approximately 1,200 cubic yards per year for the first 5 years and 600 cubic yards per year thereafter (see Measure H-1 in Chapter 7). The gravel replacement rate will be higher than the estimated natural accumulation for the first 5 years of the HCP. Gravel of various sizes will be placed in the lower Bull Run River that can be used by cutthroat trout. The placement of gravel in the lower Bull Run River to improve spawning habitat for Chinook and steelhead, however, may have little effect on cutthroat trout spawning. Cutthroat choose very small tributaries or headwaters for spawning. Johnston (1981) suggested they do this to minimize interactions with other salmonids. The City will monitor the effects of gravel placement to determine whether the measure should continue for the term of the HCP or should be modified.

#### *Access*

Resident cutthroat trout are found in many of the streams of the Sandy River Basin. However, the anadromous form of the coastal cutthroat has been limited in its distribution by dams and other structures. Anadromous cutthroat trout were first blocked from the upper Bull Run watershed in 1921 by construction of the Diversion Dam (approximately RM 5.9). That dam was constructed to divert Bull Run water into water conduits to serve the greater Portland metropolitan area. In 1964, as part of the Dam 2 construction, a rock weir at RM 5.8 was built to create the Dam 2 plunge pool for energy dissipation. That structure is now the upstream limit for anadromous cutthroat distribution; however, there are resident populations of cutthroat in upstream reservoirs and the upper Bull Run River reaches.

The City also blocks approximately 800 feet of Walker Creek, a tributary to the Bull Run River. Historically, this stream was probably used by anadromous cutthroat trout. Table 8-55 summarizes the historical distribution of anadromous cutthroat trout in the Bull Run watershed.

**Table 8-55. Historical Distribution of Cutthroat Trout in the Bull Run River**

| River Segment | River Miles |
|---|---|
| *Lower Bull Run River* | |
| Bull Run River (mouth to Dam 2 spillway weir) | 5.8 |
| Walker Creek | 0.15 |
| Little Sandy River (mouth to Little Sandy Dam) | 1.7 |
| Little Sandy River (Little Sandy Dam to middle waterfalls) | 5.6 |
| Little Sandy River Tributaries (upstream of Little Sandy Dam) | 2.0 (est.) |
| *Upper Bull Run River* | |
| Bull Run River (Dam 2 spillway weir up through reservoirs) | 9.2 |
| Bull Run River (free-flowing river to waterfall at RM 16.3) | 1.3 |
| South Fork Bull Run River and Cedar Creek | 10.8 |

Source: USFS, Stream Reports on the Bull Run River Watershed

Under this HCP, anadromous cutthroat access will still remain blocked at the rock weir (RM 5.8). Continued operation of the City's water supply will block approximately 21.3 miles of the upper Bull Run watershed for anadromous cutthroat. Of the total miles blocked, 12.1 miles are free-flowing river, and approximately nine river miles are inundated by City reservoirs. The effects of continued blocked access for anadromous cutthroat in the Bull Run watershed will be mitigated through other offsite conservation measures, as described in the Effects on Habitat from the HCP Offsite Measures section. Fish access to Walker Creek will be provided under the HCP. A culvert or other appropriate structure that meets fish passage criteria will be constructed so that cutthroat will have access to Walker Creek.

When PGE removes the Little Sandy Dam, anadromous cutthroat will have access to an additional 5.6 miles of the mainstem Little Sandy River and 2.0 miles of tributary streams. The City's agreement to maintain flows for fish will help retain habitat benefits from this renewed access to the historical habitat for cutthroat trout.

***Riparian Function***

The City owns land along 5.3 miles of the lower Bull Run River (1,650 acres). The City's land represents 82 percent of the riparian corridor below Dam 2. Managing these lands to protect riparian habitat (see Measure H-2 in Chapter 7) will improve habitat for cutthroat trout. Approximately 30 percent of the riparian corridor along the lower river is in late-successional (late-seral) timber that can provide immediate large wood recruitment to the channel. Further, 80 percent of the riparian corridor is of mid- to late-seral age and will provide wood to the channel at an increasing rate over the next 10 to 70 years (Cramer et al. 1997).

Analysis of shading in the lower Bull Run River indicates that riparian vegetation currently intercepts 40 to 60 percent of the total solar radiation that potentially could reach the water surface (Leighton 2002). This shading provides a substantial benefit to maintaining water temperature and will become greater over time as the vegetation continues to mature. Even with mature vegetation in the lower Bull Run, however, water temperatures will not meet ODEQ's numeric water temperature criteria (see the temperature effects analysis In Appendix G).

***Total Dissolved Gases***

Oregon's Water Quality Standards, as enforced by ODEQ, state that TDG levels should not exceed 110 percent of saturation unless flows exceed the ten-year, seven day average flood (7Q10) flow for the site [OAR 340-041-0031]. The 7Q10 flow for the lower Bull Run is 5,743 cfs. The 7Q10 flow at the upstream end of Reservoir 2 is similar, though slightly less. The City has evaluated the water system structures, valves, and turbines that could elevate TDG levels since the fall of 2005 and determined that cutthroat trout probably have very little exposure to TDG levels above 110% in the Bull Run River. There are two structures where the City has found that high levels of TDG can occur that could affect cutthroat trout, the Dam 2 spillway stilling pool and the Dam 1 spillway. Elevated TDG levels, however, rapidly dissipate at both locations. Monitoring by the City has shown that TDG supersaturation drops significantly as water passes over the rock weir at the downstream end of the stilling pool, restricting the highest exposures to a single pool. TDG levels further dissipate downstream of the rock weir. Similarly, elevated TDG levels measured in the Dam 1 spillway had dissipated to below 110% at the tailout of the spillway pool. Elevated TDG levels were also restricted to only certain parts of either spillway pool. In both spillway pools, cutthroat trout had easy access to relatively calm water where TDG levels were consistently below 110%.

Cutthroat trout are probably not impacted by TDG levels in the Bull Run River. The City, however, will continue to monitor TDG levels in the Bull Run, as described in the Effectiveness Monitoring section in Chapter 9 and Appendix F, Monitoring Plans and Protocols.

**Effects on Habitat in the Bull Run Reservoirs**

The City will operate the reservoirs during the term of the HCP to minimize impacts to both cutthroat and rainbow trout (see Measure R-1, Reservoir Operations).

The two Bull Run reservoirs have populations of cutthroat trout, rainbow trout, and cutthroat/rainbow hybrids. Operating the City's water system may have effects on cutthroat trout in five areas:

1. Access to reservoir tributary streams for spring spawning
2. Reservoir water quality
3. Entrainment through the water intakes in Reservoirs 1 and 2
4. Trapping of fish in the Dam 2 spillway approach canal during reservoir drawdown
5. Ramping rates downstream of the Dam 1 powerhouse

The following analysis is organized according to these five types of possible effects.

***Access to Reservoir Tributary Streams***

The City conducted a study of the margins of both reservoirs in the spring during the peak rainbow and cutthroat trout spawning period in 2003. The study results indicated that access to the tributary streams was easily available when reservoir water level elevations were within a few feet of full-pool elevations (full-pool elevations for Reservoirs 1 and 2 are 1,045 feet and 860 feet, respectively). Only Deer Creek on Reservoir 1 would be blocked for fish access when the reservoir elevation decreases below 1,042 feet. For every year of City operations in the Bull Run, the reservoirs have reached full-pool levels. Therefore, the City's similar continued operation of the reservoirs will ensure consistent access to reservoir tributaries for trout spawners.

***Reservoir Water Quality***

The City conducted a study in 2001 comparing water temperature and dissolved oxygen conditions throughout the depths of the reservoirs with conditions in 1996. Water quality conditions in the reservoirs in 1996 were used as the reference condition, and are indicative of whether reservoir habitat was limiting fish production.

The study results indicated that Reservoir 1 undergoes thermal stratification as the year progresses from early spring into summer. The temperature of Reservoir 2 remains relatively constant throughout its depth. The water temperatures are within the suitable range for cutthroat trout and other salmonids throughout the year. An additional study of fish growth and feeding in Reservoirs 1 and 2 concluded that trout growth was excellent and that food availability did not appear to be a limiting factor (Beak 2001b).

The vertical dissolved oxygen profiles in Figure 8-24 show the potential effects of operating the water system. The study indicated that dissolved oxygen concentration in both reservoirs was fairly uniform across depths in the early spring and began to drop at all depths as the season progressed and reservoir temperatures began to rise (Figure 8-24). A slight stratification developed in both reservoirs in the late summer, with the lowest levels of dissolved oxygen at intermediate depths (Beak 2001a).

Figure 8-24 shows that dissolved oxygen levels in the reservoirs are within the suitable range for salmonids throughout the year.

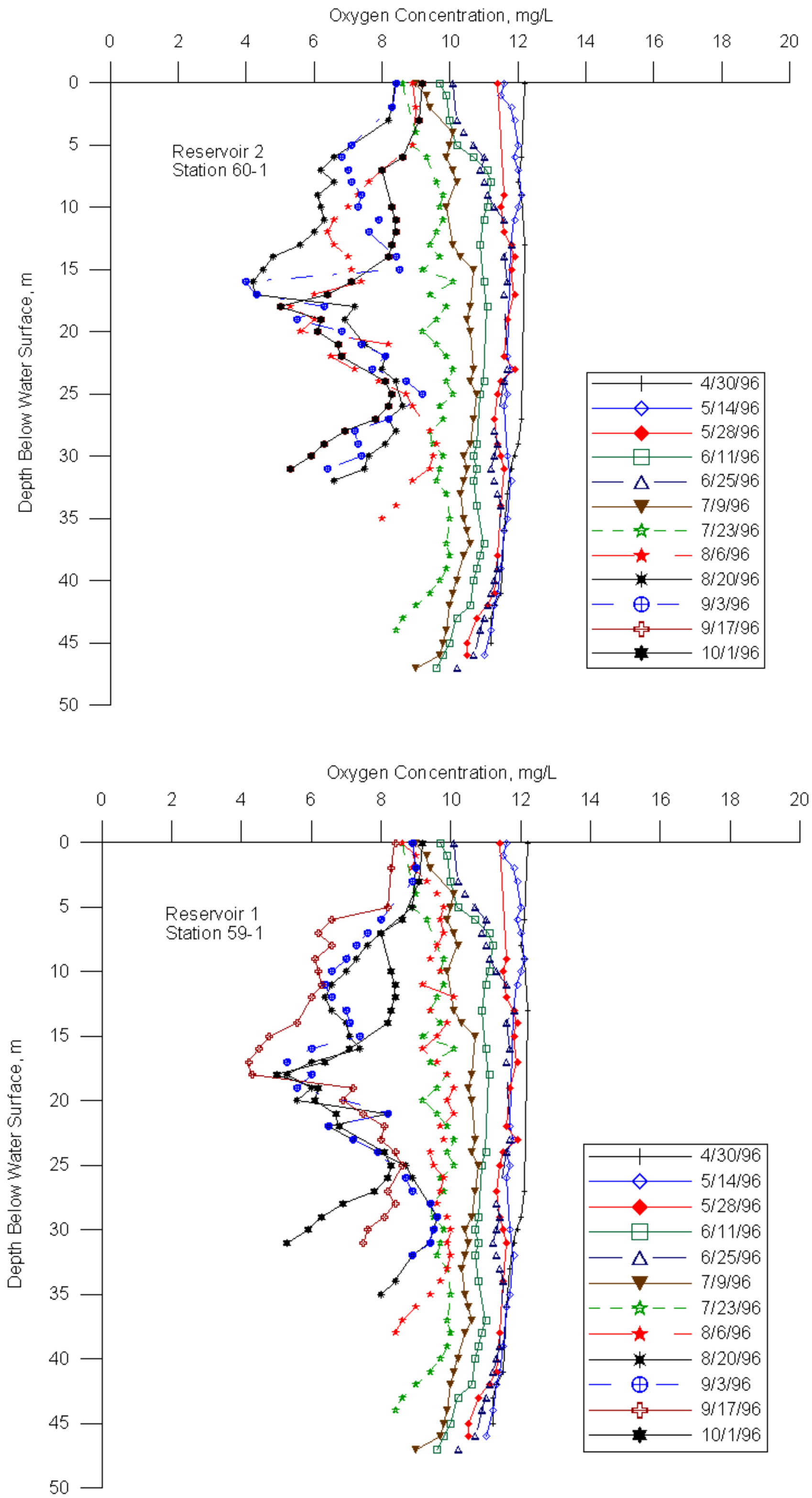


**Figure 8-24. Vertical Dissolved Oxygen Profiles for Reservoirs 1 and 2**

Source: Beak 2001a

Research on dissolved oxygen requirements for six salmonid species by EPA (1986) shows that the influence of dissolved oxygen on growth is negligible above 7 mg/L. EPA (1986) proposed 7- and 30-day mean criteria of 5 and 6.5 mg/L, respectively, for protecting other than early life stages. EPA (1986) suggested an 8 mg/L threshold as the 30-day mean criterion to protect juvenile/adult life stages, as well as developmental stages. ODEQ has established a state standard that dissolved oxygen may not be less than 8 mg/L for waters with cold-water aquatic life (OAR 340-041-0019).

At ODEQ's discretion, where adequate information exists, dissolved oxygen may not fall below 8 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day mean minimum, and 6 mg/L as an absolute minimum. Figure 8-20 shows that dissolved oxygen in the Bull Run reservoirs exceeds 8 mg/L throughout the water column of both reservoirs, except in August–September. Even during this period, dissolved oxygen exceeds 8 mg/L in about the top 5 meters of the water column and exceeds 6 mg/L in all but about the middle 20 percent of the water column.

Overall, the City's continuing operations in the Bull Run River should have minimal effects on the water quality of the reservoirs. The analysis of water quality in the Bull Run reservoirs in 1996 (Beak 2001a) indicated that the water temperature and dissolved oxygen would support populations of rainbow trout.  The City contends that cutthroat trout will also be supported due to their similar requirements.

#### *Entrainment at the Water Intakes*

The City does not have fish screens on its water intake towers in Reservoir 1 or 2 that meet current fish screening criteria.  However, the City believes that entrainment of cutthroat trout in the reservoirs is very low and it is not negatively affecting the reservoir populations of fish.  That conclusion is based on the following:

1. The cutthroat trout in Reservoir 1 and 2 no longer would demonstrate strong anadromous or fluvial life-history patterns because they have been isolated in the upper Bull Run watershed for a long time.

   All anadromous fish were blocked from the upper Bull Run River in 1921 from construction of the Diversion Dam on City property at RM 6.0.  Construction of Reservoir 1 in the 1920s and Reservoir 2 in the 1960s further isolated the cutthroat trout.  Since the trout have been isolated for over 80 years in the upper Bull Run, it is unlikely that significant numbers of fish would be trying to smolt and migrate downstream, so entrainment rates at the two dams would be related to random encounters of fish at the water intakes.

2. Only larger cutthroat trout would randomly encounter the dam intakes and they are less susceptible to entrainment.

   Adfluvial rainbow and cutthroat trout tend to remain in their natal tributaries for the first year or two (Quinn 2005, Trotter 1989, Nowak et al. 2004). All natal tributaries to Reservoir 1 and 2 are located a significant distance from the water intakes.  Fry and juveniles in lakes tend to be associated with the banks where they can find cover

(Tabor and Wurtzbaugh 1999, Bozek and Rahel 1991) and small fish that venture into open water probably would experience a high risk of predation. Before they reach the water intakes, most would probably be eaten because of adult rainbow and cutthroat trout's piscivorous behavior (Nowak et al. 2004). For these reasons, the City does not believe that small cutthroat would likely encounter the reservoir water intakes and be entrained. Larger fish, which could randomly encounter the intakes, would be better able to resist the approach velocities at the intake gates.

3. The City's operational protocols for running water though the Dam 1 or 2 water intakes will minimize the potential entrainment of cutthroat trout.

   The City does not run the reservoir powerhouses, which are located just downstream of Dams 1 and 2, continuously and that dictates the amount of water that is pulled from the reservoirs. During the summer when the reservoirs are drawn down, powerhouse use occurs primarily in the morning and evening to keep the reservoir elevations within a target range. When reservoir inflows are low, the powerhouse tends to be operated only once per day for a few hours.

4. Cutthroat entrainment at Reservoir 2 appears to be very low.

   In Reservoir 2, some cutthroat do go through the intake towers and end up in the diversion pool immediately downstream of Dam 2. In 2000, City staff drained the pool for the first time in 10 years and observed approximately 17 trapped cutthroat, from 4 to 14 inches long. City staff who are at the Headworks site 24 hours a day have never observed dead fish in the Diversion Pool. The City also conducted a hydroacoustic study of entrainment in Resevoir 2 in 2007 (Strobel 2007b). The study estimated that up to 472 fish may be entrained annually, based on very conservative assumptions of how fish would be drawn into the water intake tower. The actual number of fish entrained was probably much lower and may have been near zero. The study also estimated productivity in the reservoir and modeled the population dynamics of its cutthroat trout. The productivity calculations and modeling suggest the productivity in the reservoir could offset as much as four times the estimated maximum level of entrainment. Based on the number of fish observed in 2000 in the diversion pool and the City's hydroacoustic study, the amount of entrainment at the Dam 2 intake towers may be extremely low and the viability of the population should not be threatened.

The City believes that entrainment is not significantly affecting the cutthroat trout populations in Reservoir 1 or 2.

### *Trapping of Fish*

The City will retrieve live cutthroat trout and other salmonids, if found, from the Dam 2 spillway approach canal and return them to Reservoir 2. The fish will be retrieved and returned as soon as possible after the canal has become isolated (when Reservoir 2 drops to an elevation of about 855 feet). The trapping will occur annually unless the trapping cannot be conducted early enough in the drawdown season because of high reservoir elevations, and the trapped fish would be stressed by the trapping process; or the trapping-related mortality is too high.

This conservation measure will minimize trout mortality resulting from the City's water supply operations.

### *Ramping Rates Downstream of Dam 1*

The City believes that few cutthroat are stranded due to hydropower generation from the Dam 1 powerhouse. Dam 1 is located at the upper end of Reservoir 2, which is approximately 4.5 miles long. Over the entire length of the reservoir, only about 1,000 feet of riverine habitat is not inundated, less than 5 percent of the lineal distance between the dams. This is the only area where trout stranding could occur as a result of hydropower operations.

A hydroacoustic survey of Reservoir 2 (HTI 2000) shows that cutthroat trout are not concentrated in the upper end where there could be stranding effects. Also, the City's hydropower operations can only lower the water surface of Reservoir 2 by a maximum of 20 feet during drawdown, which restricts the area affected by downramping in the upper portion of Reservoir 2 to approximately 0.2 miles during most of the year and a maximum of 0.5 mile. Based on the small amount of habitat in which fish could be stranded and the restriction for lowering the reservoir elevation, the City believes that continued hydropower operations at Dam 1 should not negatively affect the population of cutthroat trout in Reservoir 2.

## Effects on Habitat from the HCP Offsite Measures

Cutthroat trout are probably the most common trout species in the Sandy River Basin, and the resident form is generally abundant in the Sandy River's smaller and average-sized tributaries (Taylor 1998). However, production of anadromous cutthroat is believed to be very low (Taylor 1998; ODFW 2001). Little is known about the cutthroat trout that historically used the Sandy River. Historically, approximately 20 to 30 sea-run cutthroat trout entered the Sandy Hatchery on Cedar Creek each fall, but none do so now (Hooton 1997). No large cutthroat have been counted upstream past Marmot Dam since 1977, when counting facilities became available (Cramer, PGE, pers. comm., 2005).

For this analysis, the City's potential effects on cutthroat trout were determined by examining the effects on steelhead/rainbow and coho salmon. Life history traits of cutthroat and steelhead/rainbow are very similar, and adult spawning and juvenile migration periods overlap. The habitat requirements of cutthroat also overlap with both steelhead/rainbow and coho. Each species requires high-quality spawning gravels and relatively low stream water temperatures. Cutthroat use both the slow water and off-channel habitats preferred by coho and the swift water habitats preferred by steelhead. As the habitat measures result in improved spawning and rearing habitat for steelhead/rainbow and coho salmon, so benefits to cutthroat trout should also be substantial. The habitat effects described for steelhead and rainbow trout and coho apply to cutthroat trout in the Sandy River Basin (see the sections for steelhead and coho, Habitat Effects in the Sandy River Basin from the HCP Offsite Measures, beginning on page 8-101 for steelhead and page 8-140 for coho, and Tables E-13 through E-17 for steelhead and Tables E-18 through E-20 for coho in Appendix E).

**Population Effects and VSP Parameters**

The U.S. Fish and Wildlife Service (USFWS), Tacoma Power, City, Washington Department of Fish and Wildlife, and Mobrand Biometrics provided funding and assistance in developing a set of biological rules to conduct analyses on resident and anadromous coastal cutthroat trout for the Sandy River Basin. Through a series of workshops, a draft set of rules was used to run the EDT model for cutthroat trout in December 2003 (City of Portland, Bureau of Water Works, 2004).

The EDT model run results did not produce good estimates of the VSP parameters for cutthroat because coastal cutthroat trout use very small tributaries as their primary spawning area, and habitat data were not available for many of these small streams. Without information on spawning habitat, the EDT model was unable to calculate an abundance value. Therefore, the model runs were deemed not very useful in estimating cutthroat abundance, production, or capacity.

As a surrogate for VSP parameters for cutthroat trout, the City used the VSP values generated for steelhead. As stated previously, both species have similar life histories and habitat preferences. For steelhead, productivity, diversity, and abundance would increase 7, 6, and 8 percent, respectively, with implementation of the City's Bull Run and offsite HCP measures.[16] The City asserts that habitat conditions for cutthroat and the associated VSP parameters would also improve from the HCP measures.

**Benchmark Comparison of Fish Abundance**

Model run projections of the cutthroat abundance that may accrue from the HCP measures were not possible to obtain because cutthroat trout use very small tributaries as spawning areas, and habitat data were not available for these areas. The City relied on the results of the steelhead and coho modeling efforts to project the potential effects on cutthroat. Overall, the EDT model predicted that approximately 3,880 adult steelhead could be produced under the Modified Historical Bull Run Condition scenario compared with approximately 3,560 adult fish that could be produced under the City's HCP measures.[17] For reasons stated earlier, the model predictions are very conservative. The estimate for the Modified Historical Bull Run Condition is probably very high, and the estimate for the City's HCP measures is probably low. The EDT model predicted that approximately 2,551 adult coho could be produced under the Modified Historical Bull Run Condition scenario compared with approximately 2,822 adult fish that could be produced under the City's HCP measures. Because the habitat needs of cutthroat trout are completely overlapped by those of the combination of steelhead and coho, and both steelhead and coho are predicted to benefit from the City's HCP measures, the City concludes that cutthroat trout will also benefit, although to what degree cannot be quantitatively estimated.

[16] These VSP figures assume that the Cedar Creek weir will not be removed. If the Cedar Creek weir is removed, as expected, the predicted increases in productivity, diversity, and abundance are 7, 15, and 12 percent, respectively.

[17] The estimate of abundance under the HCP measures does not take into account the removal of the Cedar Creek weir. With the additional habitat resulting from the removal of Cedar Creek weir, the abundance estimate from the City's HCP rises to 3,037.

**Conclusions about the Habitat Effects of HCP Measure Implementation**

The City assumes that the effects on habitat from the HCP offsite measures for cutthroat trout would be similar to those for steelhead and coho, since the species have overlapping habitat needs. Predicted steelhead responses illustrate particularly well how cutthroat trout are expected to benefit because their life-history traits are also so similar. Those effects are discussed in this chapter, beginning on page 8- 79 for steelhead and page 8-117 for coho. Conclusions regarding the habitat effects of implementing the HCP are listed for steelhead on page 8-114 and for coho on page 8-151.

The HCP is expected to result in both short- and long-term benefits to cutthroat trout. The conservation measures in the HCP will improve the natural processes important for creating and maintaining habitat for coastal cutthroat in the Bull Run watershed and in other areas of the Sandy River Basin.

With the additional benefits that will accrue above and beyond the core HCP measures, the City considers the HCP as a whole package to be more than adequate to compensate for impacts on cutthroat in the Bull Run watershed.

### 8.4.3 Pacific, Western Brook, and River Lamprey

Little information is available from which to discuss the potential effects of the HCP conservation measures on Pacific, western brook, and river lamprey in the Sandy River Basin as individual species. The species, however, do share some life history patterns and habitat preferences that are similar to other species covered by this HCP.

Even though Pacific, western brook, and river lamprey are widely distributed along the Pacific Coast, there is very little information on the species. Pacific and river lamprey are anadromous and parasitic during the time that they are in the ocean. Western brook lamprey do not appear to move much during their lives, and most movement is passive downstream movement when they leave the deep burrows that they entered after metamorphism.

Pacific and western brook lamprey, and probably river lamprey, spawn in the spring and construct redds in a fashion similar to anadromous salmonids. Spawning Pacific lamprey have been observed during steelhead spawning surveys (Jackson et al. 1996). The lamprey's eggs hatch quickly, and juvenile lampreys then burrow into mud or sand. The ammocoetes generally remain buried in the substrate for five or six years and feed by filtering organic matter and algae (Moyle 1976).

**Effects on Habitat in the Lower Bull Run River**

***Bull Run Base Flows***

The City's flow commitments will increase spawning and rearing habitat for several ESA-listed salmonid species; those flow commitments should increase habitat for Pacific, western brook, and river lamprey in the Bull Run watershed. Pacific and western brook lamprey, and probably river lamprey, spawn in the spring like steelhead/rainbow trout, therefore

Photo courtesy of Char Corkran.

inferences about benefits to the lamprey species can be drawn from the potential benefits of the HCP measures for steelhead/rainbow trout. The City's minimum flow of 120 cfs from December 1 through June 15 will maintain ideal spawning and incubation conditions for steelhead/rainbow trout. Since Pacific lamprey have been observed spawning in habitat similar to that preferred by steelhead (Jackson et al. 1996; Foley 1998), the City believes that spawning habitat for the three lamprey species will improve under the HCP.

Juvenile lamprey prefer mud or sand substrates for rearing habitat, and the Bull Run River has very little of that type of habitat. However, the HCP's minimum flow levels should maintain the wetted channel of the river and protect juvenile lamprey.

#### *Downramping Rates*

Substrate is the most significant factor contributing to stranding of salmonid fry (Hunter 1992). When the water surface drops, fry maintain their position and become trapped in pockets of water between cobbles. With smoother substrates, fry tend to swim around the smaller rocks. Juvenile lamprey prefer mud and sand substrates, so it is unlikely that they will get stranded in the lower Bull Run River. The City's maximum downramping rate of 2"/hour downstream of Dam 2 will ensure this outcome.

#### *Water Temperature*

The City will implement a variety of measures that will reduce water temperatures for fish in the lower Bull Run River, as discussed earlier for several anadromous salmonids. Collectively, these measures will improve water temperatures for lamprey as well.

Little information is known about the water temperature preferences of Pacific, western brook, or river lamprey. Nonanadromous western brook lamprey spawn in the spring and early summer over a temperature range of 7.8—20 °C (Scott and Crossman 1973). Those water temperatures will be maintained with the HCP water temperature measures; the City assumes that water temperatures under the HCP will be protective of spawning conditions for Pacific and river lamprey. The City was not able to determine lamprey water temperature preferences for the long period when the ammocoetes are in the fine substrate. However, the City assumes that Pacific, western brook, and river lamprey in the Sandy River

Basin have evolved with the native salmonids and prefer the natural water temperatures conditions of the various Basin streams.

Under Measure T-2, the City will complete infrastructure changes at the Dam 2 towers and the stilling basin and will commit to daily operational flow management. These changes will reduce water temperatures in the lower Bull Run River, and the City will meet the natural (historical) water temperature conditions. With these commitments, all water temperature effects on Pacific, western brook, and river lamprey will be avoided.

*Access*

The City assumes that Pacific, western brook, and river lamprey could have had the same historic distribution as steelhead in the Bull Run watershed. That assertion is supported by others who are familiar with the passage capabilities of the lamprey (Kostow, ODFW, pers. comm., 2005). Table 8-56 summarizes the historical distribution of lamprey in the Bull Run watershed.

**Table 8-56. Historical Distribution of Lamprey in the Bull Run River**

| River Segment | River Miles |
|---|---|
| *Lower Bull Run River* | |
| Bull Run River (mouth to Dam 2 spillway weir) | 5.8 |
| Walker Creek | 0.15 |
| Little Sandy River (mouth to Little Sandy Dam site) | 1.7 |
| Little Sandy River (Little Sandy Dam site to middle waterfalls) | 5.6 |
| Little Sandy River Tributaries (upstream of Little Sandy Dam site) | 2.0 (est.) |
| *Upper Bull Run River* | |
| Bull Run River (Dam 2 spillway weir up through reservoirs) | 9.2 |
| Bull Run River (free-flowing river to waterfall at RM 16.3) | 1.3 |
| Bull Run River (RM 16.3 to 80-ft waterfall) | 5.4 |
| South Fork Bull Run River | 2.7 |
| Cedar Creek (tributary to South Fork Bull Run River) | 8.1 |
| Camp Creek | 0.6 |
| Fir Creek | 0.5 |
| Bear Creek | 0.3 |
| Cougar Creek | 0.7 |
| Deer Creek | 0.5 |
| North Fork Bull Run River | 0.8 |
| Log Creek | 0.2 |
| Falls Creek | 0.8 |
| West Branch Falls Creek | 0.3 |
| Blazed Alder Creek | 2.4 |
| Blazed Alder tributaries | 0.4 (est.) |

Source: USFS, Stream Reports on the Bull Run River Watershed, 1999

The City constructed a lamprey barrier at approximately RM 5.9 on the mainstem Bull Run River to keep adult lamprey and ammocoetes out of the Diversion Pool where unfiltered water enters the conduits for Portland's drinking water. Under this HCP, lamprey access will remain blocked at the lamprey barrier, preventing lamprey access to approximately 34 miles of the upper Bull Run watershed. Of the total miles blocked, 25 miles are free-flowing river and approximately 9 river miles are inundated by City reservoirs. This analysis is very conservative and assumes that lamprey historically were able to migrate upstream of a series of three waterfalls on the mainstream Bull Run River at RM 16 – RM 16.65.

Fish access to Walker Creek will be provided under the HCP. A culvert or other appropriate structure that meets fish passage criteria will be constructed so that lamprey will have access to Walker Creek.

Once PGE removes the Little Sandy Dam, lamprey will be able to utilize an additional 7.3 miles of the mainstem Little Sandy River and 2 miles of tributary streams.[18] The City will maintain flow conditions in the Little Sandy River to benefit lamprey and other fish species (see Measure F-4, Chapter 7).

This HCP has several conservation measures that will increase the available miles of lamprey habitat in other streams in the Sandy River Basin. Those effects are discussed in the following section.

### Effects on Habitat from the HCP Offsite Measures

The conservation measures in the HCP are expected to maintain the natural processes important for creating and conserving habitat for Pacific, western brook, and river lamprey in the Sandy River Basin. The HCP is expected to result in short- and long-term benefits to lamprey, compared with the current conditions.

This HCP contains 30 conservation measures outside of the Bull Run watershed that will improve habitat conditions for lamprey. The five general types of measures, fish passage, carcass placement, riparian improvements, water rights acquisition, and in-channel improvements, are discussed below.

#### *Fish Passage*

Fish passage improvements at Alder Creek will increase the available space and habitat distribution of lamprey in the Sandy River Basin.

#### *Carcass Placements*

Carcass placements will provide short-term benefits for lamprey in the Sandy River Basin. This conservation measure will increase nutrient levels, primary and secondary aquatic productivity, and, subsequently, the survival, growth, and abundance of lamprey.

[18] See Section 4.1.5 Water Quality and Water Rights for more information about the removal of the Little Sandy Dam.

#### *Riparian Improvements*

The City HCP riparian improvement projects in 19 stream reaches with predicted improvements to habitat conditions in 21 offsite Sandy River Basin reaches. The riparian improvements will provide wood recruitment, shade, bank stabilization, and runoff filtration capacity over time that will increase the survival, abundance, and productivity of lamprey in the Basin.

#### *Water Rights Acquisition*

The city will pursue purchasing water rights in Cedar Creek to increase flows for fish, including lamprey.

#### *In-channel Improvements*

The City has identified in-channel improvements in 13 stream reaches of the Little Sandy and Sandy rivers. The work includes large wood placements and introductions, log jam creation, instream enhancement, channel design, channel reconstruction, river mouth reestablishment, bank restoration, side-channel construction, and channel restoration. All of the in-channel improvements should increase the survival, abundance, and productivity of lamprey in the Sandy River Basin.

### Population Effects and VSP Parameters

There is no information to determine the population status of the three lamprey species addressed in this HCP.

### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP measures within the Bull Run watershed and elsewhere in the Sandy River Basin are expected to maintain the natural processes important for creating and maintaining habitat for the three lamprey species. The flow commitments in the HCP will result in both short- and long-term benefits to lamprey that represent improvements over the habitat conditions in place for the Bull Run River prior to the City releasing flows for salmonids (in the late 1990s).

## 8.5 Amphibians and Reptiles

In this HCP, the City addresses the following amphibians and reptiles: western toad, Cascades frog, northern red-legged frog, coastal tailed frog, Cope's giant salamander, Cascade torrent salamander, clouded salamander, Oregon slender salamander, the western painted turtle, and the northwestern pond turtle. The effects of the City's HCP on these species are described in the following subsections:

- Effects of the Bull Run water supply operations and related activities
- Effects of the Bull Run HCP measures
- Effects of the offsite HCP measures

### 8.5.1 Western Toad *(Bufo boreas)*

The only known breeding site in the Sandy River Basin is the north side of Bull Run Reservoir 1, where an extensive bench is inundated when the reservoir is at full pool.

#### Effects of Bull Run Water Supply Operations and Related Activities

The permanent water supply facilities will continue to have slight, negative long-term effects on western toads. The dams and large reservoirs pose impediments to migration of adult toads and dispersal of metamorphs. While the dams can be circumnavigated, the large bodies of water make hazardous crossings because of the presence of trout, river otters, and other predators. The presence of the log booms, roads, bridges, power lines, and other facilities has no known effect on western toads.

Normal operation of the water supply will continue to have positive long-term effects on western toads in the Bull Run watershed. Water stored in the reservoirs, which inundates the benches at the upper end of Reservoir 1, creates ideal breeding habitat that is used annually by this species. Over decades of continued water storage, extensive bars of fine debris have built up at the reservoir's head, which may be increasing the available breeding habitat. However, the recent invasion of reed canarygrass *(Phalaris arundinacea)* has reduced the value of the site. This exotic grass covers the organic mud and fine debris used by the toads for egg deposition, tadpole foraging, and dispersal of metamorphs. It also shades the water and substrate, which slows the temperature-dependent development of eggs and larvae. Withdrawal of water from the Bull Run River below the reservoirs will continue to have negligible long-term effects on western toads. Riparian forests are used by some toads for migration and summer foraging, with the wetted edge of the river being used for water absorption and some foraging. Having to travel farther from the forest to get to water increases the toads' exposure to predation; however, few individual toads will use the lower Bull Run River.

Annual operation of the reservoirs has positive effects on the western toads because it mimics a natural water regime. The local toad population has adjusted its breeding time to June to take advantage of the seasonal dam gate closure, inundation of the bench habitat, and gradual summer drawdown of the water level in Reservoir 1. In drought years, some tadpoles are stranded on the debris flats by early drawdown, but this is a natural phenomenon that occurs at all toad breeding sites. At least one pool on the north bench retains water even through drought summers and produces western toad metamorphs in most years.

Other annual activities such as routine maintenance, use of boats on the reservoirs, driving on project roads and bridges, and hydropower generation have little or no effect on western toads. Removal of floating logs from Reservoir 1 decreases the available hiding cover for toadlets and basking sites for adults. Not all logs are removed, however, and before the dams were built, many logs would have been transported away from the site by high river flows. Boats generally do not disturb the extreme north shallows of Reservoir 1 where eggs are laid in June and tadpoles congregate in summer. Because this breeding site is not near any project roads, neither migrating adult toads nor dispersing metamorphs are especially vulnerable to being run over by vehicles (the nearest USFS road is also at a safe distance away). The light foot traffic that occurs on the Station 18 Trail at the time of toadlet dispersal does not constitute a threat to annual recruitment to the population.

#### Effects of the Bull Run Measures

The habitat conservation measures in the HCP will have negligible long-term effects on the western toad population because few individuals use the affected areas. Instream flow commitments for the lower Bull Run River will have little influence on summer water levels in Reservoir 1. Higher instream flows will decrease the distance to water for the few adult toads that may summer in riparian areas, thus minimizing their exposure to predators. Cold water allocations to the lower Bull Run River will have little effect on adult toads that may summer there because water temperature is not a factor for water absorption, and because the water will not be cold enough to limit numbers of invertebrate prey used by the toads.

The City will cut reed canarygrass annually from three areas along the upper end of Reservoir 1 to improve breeding conditions for western toads. Annual cutting of the invasive grass will allow the side-channel benches to warm up enough for successful toad breeding and rearing. Other Bull Run habitat improvement and preservation measures will have limited positive effects on western toads because the majority of the Bull Run toad population is higher up in the watershed. Gravel placement will not affect toads because they do not use the stream substrate. Preservation of riparian areas will maintain summer habitat for the few adults likely to use these river reaches during summer.

#### Effects of the HCP Offsite Measures

Offsite habitat enhancement and protection will have limited positive effects on western toads in the Sandy River Basin because most measures will occur in areas not frequently used by this species. Easements and enhancements on the Salmon River could positively affect the few adult toads that may travel into that area from an adjacent river basin because these measures will protect riparian habitat that may be used for summer foraging. Control of invasive plant species in the Sandy River Basin, associated with the HCP's riparian easements, could have positive effects on western toads over the long term if it improves habitat in areas used by this species, but negative effects in the short term if it involves tools or techniques that are harmful to toads.

#### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have mostly positive effects on western toads in the Sandy River Basin. The Bull Run population primarily uses Reservoir 1 and the upper Bull Run watershed rather than the other tributaries of the Sandy River; however, toads are known to travel long distances and may spend summers in riparian areas more than three miles from breeding sites (Thompson 2004). Consequently, most of the activities covered by this HCP will affect few, if any, individual western toads.

### 8.5.2 Cascades Frog *(Rana cascadae)*

#### Effects of Water Supply Operations and Related Activities

The permanent water supply facilities will have no effect on Cascades frogs because the species does not occur in the reservoirs or near the dams. Project roads, bridges, power lines, and other facilities have no known influence on the species.

Normal operation and maintenance of the project will have no effect on Cascades frogs because they do not occur in the immediate area of these activities. Water storage in the reservoirs, withdrawal of water from the lower Bull Run River, annual filling and drawdown of Reservoir 1, debris removal, use of boats on the reservoirs, driving on project roads and bridges, hydropower generation, and routine facility maintenance will occur outside of the known geographic range of this species.

Photo courtesy of Char Corkran.

### Effects of the Bull Run HCP Measures

The habitat conservation measures in the HCP will have limited positive effects on Cascades frogs because the measures will occur outside or at the lower edge of the known geographic range of the species. Instream flow commitments and cold water allocations to the lower Bull Run River, as well as onsite habitat improvement and preservation measures in the lower Bull Run River and lower Little Sandy River, will not affect Cascades frogs, which have never been found in those areas.

### Effects of the HCP Offsite  Measures

A few of the offsite habitat improvement and preservation measures will slightly benefit Cascades frogs. Adults from populations breeding near the headwaters of Cedar Creek probably summer along the upper portions of Cedar and Alder creeks. Riparian easements and improvements in these areas will preserve and enhance summer foraging and migration habitat for frogs as well as fish. Similarly, riparian easements on the upper sections of the Zigzag and Salmon rivers will preserve summer habitat for frogs that breed nearby, and placement of salmon carcasses will increase invertebrate prey abundance. Control of invasive plant species in the Sandy River Basin, associated with the HCP'S riparian easement, could have positive effects on Cascades frogs over the long term if it improves habitat in areas used by this species, but negative effects in the short term if it involves tools or techniques harmful to frogs.

### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have limited positive effects on Cascades frogs in the Sandy River Basin. Because this is primarily a high-elevation species, few individual Cascades frogs are present in the areas affected by the covered activities.

## 8.5.3 Northern Red-legged Frog *(Rana aurora aurora)*

### Effects of Water Supply Operations and Related Activities

The permanent project facilities will continue to have minor, negative long-term effects on northern red-legged frogs. The dams and large reservoirs somewhat hinder the migration of adult frogs and dispersal of metamorphs. Although the dams can be circumnavigated by this very active species, crossing the reservoirs makes frogs vulnerable to trout, river otters, and other predators. The log booms, roads, bridges, power lines, and other facilities have no known effect on northern red-legged frogs.

Normal operation of the water supply will continue to benefit northern red-legged frogs. Storage of water in the Bull Run reservoirs provides breeding habitat at the upper end of Reservoir 1, particularly the bench at the mouth of Fir Creek. Long-term water storage has resulted in extensive bars of fine debris, which may be increasing available breeding habitat. However, the reservoirs also provide habitat that attracts American beaver (Castor canadensis) whose activity affects the growth of small willows used for egg attachment by the frogs in the limited shallow habitat. Recent invasion by reed canarygrass could impact native sedges and other vegetation used by red-legged frogs for egg deposition and larval development.

Withdrawal of water from the Bull Run River below the reservoirs will continue to have slight, negative long-term effects on northern red-legged frogs. From the large breeding population near the south side of Reservoir 2, some adult frogs are likely to use the riparian forest and stream edge along the lower Bull Run River for summer foraging, migration corridors, and possibly winter residency. The drop in the water level increases the distance from water to forest, which increases the frogs’ exposure to predation and may reduce moisture in logs and vegetation used for cover.

Annual operation of the reservoirs has mostly positive effects on red-legged frogs because it creates natural flow cycles and therefore provides usable habitats at appropriate times of year. The water level in Reservoir 1 is kept at least 10 feet below full pool during the winter when northern red-legged frogs gather for breeding. At that water level, vegetation used for egg attachment is at appropriate water depths, although some areas probably approach the maximum usable depth. By the time the gates on Dam 1 are closed in spring and the reservoir is at full pool, eggs in shallower water have already hatched and the small larvae can follow the water line to find optimum conditions for rapid growth. Hatching success of egg masses in the deeper water areas has not been monitored after the reservoir is at full pool, but hatching is delayed by colder conditions and therefore some eggs may not hatch at all. The gradual summer drawdown in Reservoir 1 follows a natural pattern that warms the water in the shallows and fosters growth of tadpoles and their food. In years with a dry spring, some egg masses are stranded by receding water levels, which is a normal phenomenon. Even in years with a dry spring and summer, some pools retain water long enough for tadpoles to complete metamorphosis.

Other project-related activities, such as routine maintenance, use of boats on the reservoirs, driving on project roads and bridges, and hydropower generation, have little or no effect on red-legged frogs. Removal of floating logs from Reservoir 1 decreases the available hiding cover, but not all logs are removed, and the dams artificially prevent logs from being transported away from the site by high river flows. Boats generally do not enter the shallows of Reservoir 1 when eggs are present in February, and the usual timing of debris removal occurs after the few egg masses in the shallows near the upper log boom have already hatched. Summer use of boats generally does not disturb tadpoles congregating in the shallowest edges. Because the primary breeding sites are not near any project roads, neither migrating adult frogs nor dispersing metamorphs are particularly vulnerable to being run over by vehicles (the nearest USFS road is also at a safe distance away).

### Effects of the Bull Run Measures

Instream flow commitments in the lower Bull Run River will benefit frogs residing in the riparian zone because increased flows will reduce the distance from forest to water, thereby reducing the frogs’ exposure to predation and retaining more moisture in substrate and cover objects near the forest edge. Cold water allocations to the lower Bull Run River will benefit resident adult frogs because this species prefers cool, moist conditions, yet the water will not be cold enough to limit numbers of invertebrate prey.

The City will cut reed canarygrass annually from three areas along the upper end of Reservoir 1 to improve breeding conditions for red-legged frogs. Annual cutting of the invasive grass will allow the side-channel benches to warm up enough for successful frog breeding and rearing.

Bull Run habitat improvement and preservation measures will have positive long-term effects on northern red-legged frogs. Gravel placement will briefly disturb resident adult frogs but will have no long-term effect because the frogs do not use the river substrate except for occasional escape from terrestrial or aerial predators. Preservation of riparian areas will maintain habitat used for much of the year by resident adult frogs.

#### Effects of the HCP Offsite Measures

Offsite habitat enhancement and protection measures will have positive long-term effects on northern red-legged frogs in the Sandy River Basin. Riparian easements and improvements including large wood placement will benefit frogs where they occur in the lower reaches of the Sandy and Salmon Rivers and in all the creeks where activities are planned. Improving fish passage will not affect red-legged frogs because the frogs rarely enter the streams and because the species can withstand occasional predation by native salmon and steelhead with which it evolved. Placement of salmon carcasses will increase invertebrate prey abundance for frogs. Channel reconstruction and reestablishment of the mouth of the Sandy River may benefit red-legged frogs because increasing the influence of river flows through the delta may favor native fish species over introduced fish and American bullfrogs, both of which pose unnatural risks of predation, competition, and disease. Control of invasive plant species in the Sandy River Basin, associated with the HCP's riparian easements, could benefit red-legged frogs over the long term by replacing stands of weed species with diverse native plant communities that may harbor more diverse and numerous invertebrate prey for adult frogs and provide better hiding cover. Weed control measures could have short-term impacts on red-legged frogs if the measures temporarily remove vegetation and/or physically displace or kill frogs.

#### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have mostly positive long-term effects on northern red-legged frogs in the Sandy River Basin. The species occurs throughout the lower portions of the Basin where most of the covered activities will occur. Large breeding sites occur in and near the Bull Run reservoirs. The species is closely associated with riparian forests (Blaustein et al. 1995; Hallock and McAllister 2005).

### 8.5.4 Coastal Tailed Frog *(Ascaphus truei)*

The coastal tailed frog occurs in many of the headwater and tributary streams in the Basin, some of which are influenced by the covered activities. These frogs are apparently dependent on undisturbed riparian and old-growth conifer forests associated with moderate or high gradient streams (Bury et al. 1991a; Bury et al. 1991b; Welsh 1990).

### Effects of Water Supply Operations and Related Activities

The permanent project facilities will continue to have slight, negative effects on coastal tailed frogs. The dams and large reservoirs are slight impediments to the movement of adults and metamorphs. Although the frogs may circumnavigate the dams, crossing the reservoirs makes them vulnerable to trout, river otters, and other predators. Furthermore, the reservoirs may be sinks for larvae that are carried in from the Bull Run River and from small streams because the reservoir may become too warm, have insufficient oxygen, have silt covering the rocks, and may not provide appropriate food sources for larval survival. Culverts may impose barriers to migration of adults and dispersal of metamorphs. The log booms, roads, bridges, power lines, and other facilities have no known effect on coastal tailed frogs.

Normal operation of the water supply will continue to have slight, negative effects on coastal tailed frogs. Withdrawal of water from the lower Bull Run River will have low impact because most tadpoles and adults occur in and adjacent to smaller streams. Tadpoles carried into this river section from small tributaries may be negatively impacted by the relatively warmer, shallower water in these reaches because the water is beyond the shade of adjacent trees and flanked by heat-holding rocks. The following activities have no known effects on the coastal tailed frog: annual operations that result in fluctuations in the reservoir levels, debris removal, use of boats, driving on project roads, hydropower generation, and routine maintenance activities.

### Effects of Measures in the Bull Run Watershed

Bull Run habitat improvement and preservation measures will have only slight positive long-term effects on coastal tailed frogs because few larvae and even fewer adults occur in and along the lower sections of either the Bull Run or Little Sandy rivers. Gravel will be placed in deeper water than is normally used by adult frogs, and larvae are more apt to use coarser substrate. Preservation of riparian areas will maintain habitat for the few adult frogs using stream edges.

### Effects of the HCP Offsite Measures

Coastal tailed frogs are present in several of the Sandy River Basin streams where offsite habitat enhancement and protection measures are planned. Riparian easements and enhancements on Gordon, Trout, Alder, and Cedar creeks will maintain shade, protect soil, and provide future sources of large wood. Both larval and adult tailed frogs will benefit from cool silt-free water and logs for hiding cover. Placement of large wood will provide cover for the short term. Instream enhancements and improved fish passage will not seriously affect tadpoles or adult frogs. Although the frog population may retreat somewhat from lower stream sections because of predation from fish that will again be able to access higher reaches, coastal tailed frogs evolved in the presence of these fish species and are capable of avoiding excessive predation pressure. Control of invasive plant species in the Sandy River Basin, associated with the HCP's riparian easements could have positive effects on tailed frogs over the long term if it improves habitat in areas used by this species, but negative effects in the short term if it involves tools or techniques harmful to frogs.

#### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have minor, mostly positive long-term effects on coastal tailed frogs in the Sandy River Basin. Both instream flow commitments and cold water allocations for the lower Bull Run River will create stream conditions somewhat better able to support any tadpoles that are carried in from small tributaries.

### 8.5.5 Cope's Giant Salamander *(Dicamptodon copei)* and Cascade Torrent Salamander *(Rhyacotriton cascadae)*

Both the Cope's giant salamander and Cascade torrent salamander occur in at least several of the headwater and small tributary streams in the Basin, while most activities covered in the HCP will take place lower in the Basin. These two salamander species are dependent on cold silt-free streams that are usually associated with undisturbed riparian and old-growth conifer forests (Bury and Corn 1988; Bury et al. 1991b; Corn and Bury 1989; Corkran unpublished data).

#### Effects of Water Supply Operations and Related Activities

The permanent project facilities will have slight, negative long-term effects on Cope's giant salamanders and Cascade torrent salamanders. The dams and large reservoirs are slight impediments to dispersal between tributary streams. Although Cope's giant salamander occasionally is found in large cold lakes, the substrate of the reservoirs is too silty to provide appropriate habitat. Crossing the reservoirs also makes both salamander species vulnerable to trout, river otters, and other predators. Culverts can impose barriers to movement of all aquatic salamanders within streams and limit foraging opportunities. The log booms, roads, bridges, power lines, and other facilities have no known effect on these two species.

Normal operation of the water supply will have slight, negative long-term effects on Cope's giant salamander and Cascade torrent salamander. Withdrawal of water from the lower Bull Run River will have no impact because neither species occurs there. Annual operations that result in fluctuations in the reservoir levels, debris removal, use of boats, hydropower generation, and routine maintenance activities will continue to have no known effects on these two species. Driving on project roads could threaten dispersing salamanders attempting to cross these roads.

#### Effects of the Bull Run Measures

Instream flow commitments and cold water allocations for the lower Bull Run River will have no effect because neither species occur in the river. If there are seeps, springs, or small tributaries along the lower Bull Run River, either or both species could occur; however, neither the water flow level nor the water temperature would affect habitat occupied by these two species.

Bull Run habitat improvement and preservation measures probably will have no effect because these two species do not occur in the lower Bull Run River and are not known to occur in the Little Sandy River. However, if there are seeps, springs, or small tributaries in a


Photo courtesy of Char Corkran.

planned project area along either the lower Bull Run River or the Little Sandy River, then these species may be present. If present, they would not be affected by gravel placement because it would be placed only in the main channels. In addition, both species would benefit from riparian preservation because it would retain shade and bank stability at the mouths of small tributaries, as well as the lower Bull Run and Little Sandy rivers.

### Effects of the HCP Offsite Measures

Offsite habitat enhancement and protection measures will slightly benefit Cope's giant salamanders and Cascade torrent salamanders where these two species occur. Riparian easements and enhancements on Gordon, Trout, Alder, Boulder, and Cedar creeks will maintain shade, protect soil, and provide future sources of large wood. Both salamander species are known or suspected to occur at the heads of these streams and may occur where covered activities are planned. These two species would benefit from riparian easements and enhancement projects because such measures would maintain or improve cold silt-free water and would provide logs for hiding cover and nest sites. Instream enhancements and improved fish passage will not seriously impact either of these salamander species. Although they may retreat somewhat from lower stream sections because of predation from fish that will again be able to access higher reaches, Cope's giant salamander and Cascade torrent salamander evolved in the presence of these fish species and have adapted to avoid excessive predation pressure.

Control of invasive plant species in the Sandy River Basin, associated with the riparian easements, could have positive effects on these salamanders over the long term if it improves habitat in areas used by the species; effects could be negative in the short term if the control involves tools or techniques harmful to salamanders. Invasive plants can adversely affect salamanders by reducing diversity and abundance of invertebrate prey species, although these salamanders mostly occur in undisturbed areas that have not been severely impacted by invasive plants.

#### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have minor, mostly positive effects on Cope's giant salamanders and Cascade torrent salamanders in the Sandy River Basin.

### 8.5.6 Clouded Salamander *(Aneides ferreus)* and Oregon Slender Salamander *(Batrachoseps wrightorum [= wrighti])*

Clouded salamanders and Oregon slender salamanders occur primarily in upland coniferous forests, while the activities covered by the HCP will take place predominantly in riverine and riparian forest habitats.

#### Effects of Water Supply Operations and Related Activities

The permanent project facilities will have slight, negative long-term effects on clouded salamanders and Oregon slender salamanders. The dams may slightly impede dispersal and foraging travel, but these two species are not known to travel long distances or along riparian forest corridors. The large reservoirs are similar to rivers in hindering dispersal, although it is possible that salamanders hiding in logs that slid downhill could be transported more easily across a reservoir than across a river. The project roads and the power lines may impose barriers to dispersal of clouded and Oregon slender salamanders, neither of which is normally found out in the open, even at night. Roads offer no hiding cover and make salamanders vulnerable to predation when crossing. Power lines are maintained to prevent growth of large trees that provide logs, and these salamanders may have difficulty traveling far enough to cross them without logs to provide habitat for foraging and resting along the way. Culverts, log booms, bridges, and other facilities have no known effect on these two species.

Normal operation of the water supply will have negligible effects on clouded salamanders and Oregon slender salamanders. Storage of water will have the same effects as discussed above for the presence of the reservoirs. Withdrawal of water from the lower Bull Run River will have no impact because these two species do not occur in rivers and are not reliant on riparian forests that could be dried by reduction in flows. Driving on project roads could impact salamanders that attempt to cross them, although most driving occurs during the day, and the salamanders are primarily nocturnal. Other annual operations that result in fluctuations in the reservoir levels, use of boats, hydropower generation, routine maintenance activities, and debris removal will have no known effects on these species because they do not use the reservoirs or other facilities.

Removal of logs from the reservoirs would not deprive the salamanders of habitat because once the logs slide or fall into the river or reservoir they would not be used by these upland species. It is possible, however, that occasionally salamanders could be inside logs when they entered the reservoir. If these logs were removed and transported to rivers at other locations in the Sandy River Basin, those few individuals might not survive the drying associated with log storage and might not be capable of traveling from the new position in a river to appropriate terrestrial habitat.

#### Effects of the Bull Run Measures

The habitat conservation measures in the HCP will have slight, positive long-term effects on clouded salamanders and Oregon slender salamanders. Instream flow commitments and cold water allocations for the lower Bull Run River will have no effect because these species do not occur in rivers and are not dependent on riparian forests influenced by the higher flows.

Bull Run habitat improvement and preservation measures will have only slight positive long-term effects on clouded salamanders and Oregon slender salamanders because the measures will not affect the primary habitat of these species. Placement of gravel will occur in the rivers, but these salamanders are entirely terrestrial. Preservation of riparian areas will maintain habitat and provide sources of future logs for the few individuals of these two species that may use these areas.

#### Effects of the HCP Offsite Measures

Offsite habitat enhancement and protection measures will only slightly benefit clouded salamanders and Oregon slender salamanders in the Sandy River Basin because these species primarily occur in upland forests. Riparian easements on tributary streams in the Basin will maintain and provide future sources of logs. Neither placement of large wood nor enhancements that improve fish passage will affect these species because they do not use rivers.

Control of invasive plant species in the Sandy River Basin, associated with the riparian easement, could have positive effects over the long term if it improves habitat in areas used by these two species, but it could have negative effects in the short term if tools or techniques harmful to salamanders are used. Invasive plants can adversely affect salamanders by reducing diversity and abundance of invertebrate prey species, although the salamanders mostly occur in undisturbed areas that have not been severely impacted by invasive plants.

#### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have minor, mostly positive effects on clouded salamanders and Oregon slender salamanders in the Sandy River Basin.

### 8.5.7 Western Painted Turtle *(Chrysemys picta belli)* and Northwestern Pond Turtle *(Emys [= Clemmys] marmorata marmorata)*

The western painted turtle occurs near the mouth at the Sandy River delta, and individual northwestern pond turtles may be present at the delta.

#### Effects of Water Supply Operations and Related Activities

Normal operation of the water supply will have little effect on western painted turtles and northwestern pond turtles. Storage of water will not affect them because they do not occur near the reservoirs. Similarly, withdrawal of water from the lower Bull Run River will have little impact because neither turtle species occurs in the Bull Run River. They have not been documented in the Sandy River near its mouth, but only in ponds in the Sandy River delta, which are not affected by withdrawal of water from the Bull Run River. If the two turtle species did use the Sandy River at its mouth, withdrawal might be slightly beneficial because it would decrease flow and allow warming of the water. Annual operations that result in fluctuations in the reservoir levels, debris removal, use of boats, driving on project roads, hydropower generation, and routine maintenance activities will have no effect on the two species because they do not occur where the covered activities will take place.

### Effects of the Bull Run Measures

The habitat conservation measures in the HCP will have little effect on western painted turtles and northwestern pond turtles. Instream flow commitments and cold water allocations for the lower Bull Run River will be unlikely to affect these species because they do not occur in the Bull Run River, and they primarily use ponds rather than the Sandy River near its mouth. If the two species did use the Sandy River at its mouth, instream flow commitments and cold water allocations might be slightly detrimental because the turtles prefer warm water.

Bull Run habitat improvement and preservation measures will have no effect on western painted turtles and northwestern pond turtles because neither species occurs in the Bull Run or Little Sandy rivers.

### Effects of the HCP Offsite Measures

Offsite habitat enhancement and protection measures will provide slight long-term benefit to the two turtle species because the species do not occur where most of the activities will take place. An exception is the planned channel reconstruction and reestablishment of the mouth of the Sandy River. Reconnecting the east channel, which is now a slough blocked at its upstream end, will cause short-term disturbance to turtles using that area. Nest surveys should be conducted prior to initiating the work. However, the project may have long-term benefits because it will restore conditions for salmonids and make the area less suitable for introduced warm-water fish and American bullfrogs, which then might also be eradicated from the isolated ponds on the delta. If the channel restoration also creates more natural overflows and channel banks, the two turtle species may make further use of the area.

Control of invasive plant species in the Sandy River Basin, associated with riparian easements, could have positive effects on turtles over the long term if it improves habitat in areas used by the species; the control could have negative effects in the short term if tools or techniques harmful to turtles are used. Invasive plants, such as Himalayan blackberry (Rubus discolor) and reed canarygrass, are detrimental to sites for these two turtle species because they create shade and barriers to movement on banks of ponds and rivers used by these species, and their roots interfere with digging into the soil for nest building. Control of these plants will restore suitable basking, dispersal, and nesting conditions.

### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have very limited positive effects on western painted turtles and northwestern pond turtles in the Sandy River Basin. Most activities covered in the HCP will occur higher in the basin than in western painted turtle and northwestern pond turtle habitat. The permanent project facilities, including dams, reservoirs, culverts, log booms, project roads and bridges, power lines, and other facilities will have no effect on the two turtle species because neither one occurs in the area of the facilities.

## 8.6 Birds and Mammal

In this HCP, the City addresses two birds and one mammal: the bald eagle, the northern spotted owl, and the fisher. The effects of the City's HCP on these species are described in the following subsections:

- Effects of water supply operations and related activities
- Effects of the HCP measures
- Conclusions about the habitat effects of HCP measure implementation

### 8.6.1 Bald Eagle *(Haliaeetus leucocephalus)*

#### Effects of Water Supply Operations and Related Activities

As described in Chapter 5, bald eagle presence in the Bull Run watershed is limited to occasional use of the reservoirs by transient bald eagles and to a single nesting territory below the confluence with the Little Sandy River (outside the area directly affected by the water supply system). Existing water system facilities, with the possible exception of power lines, will have little direct effect on bald eagles.

Overhead power lines can impact bald eagles through collisions and electrocutions (Franson et al. 1995). Avian electrocutions occur more frequently from distribution lines than from transmission lines, because the closely spaced conductors of the former are more easily bridged by birds (Avian Power Line Interaction Committee 1996, cited in Hunting 2002b; Dorin et al. 2005). Distribution line locations are described in Section 8.7, Table 8-57. Generally, these lines are located adjacent to the lower Bull Run River along the main road downstream of Dam 1.

The potential for bald eagles to be affected by power lines covered by the HCP is currently considered low due to the relatively low resident bald eagle population and the bald eagle's ability to avoid collisions with overhead power lines except during periods of poor visibility. The low potential is supported by the absence of any reported bald eagle collisions with power lines in the Bull Run watershed (Marheine, PGE, pers. comm., January 30, 2006). The potential for collision and/or electrocution does exist, however, and could increase in the future if the bald eagle population increases. Power line mortality, however, is generally not considered to cause a measurable population decline in otherwise healthy bald eagle populations (Olendorff et al. 1989, cited in Herbert et al. 1995). This appears to be the case in Oregon, where bald eagle populations have been stable or increasing in recent years despite the presence of numerous power lines.

Routine covered activities such as vehicle traffic on regularly used roads and daily human activity near developed facilities are not expected to disturb bald eagles. These activities occur in relatively confined areas, and bald eagles would become accustomed to such activities or could readily avoid the areas. Less frequent activities, such as right-of-way maintenance and the use and maintenance of roads with little regular traffic, would have the potential to cause a low level of disturbance to bald eagles, depending on the season and the proximity to nesting, roosting, and foraging areas. These activities are restricted to relatively

Photo courtesy of Char Corkran.

defined areas (e.g., roadways, existing structures) where human activity is a regular occurrence and bald eagle activity is expected to be limited. The potential for disturbance-related impacts to bald eagles from these activities would be minimized or avoided altogether by seasonal restrictions and disturbance buffers required under Measure W-2. In cases when these activities cannot be scheduled to avoid disturbing bald eagles (such as emergency repairs to roads or power lines), minor levels of disturbance could occur. It is not anticipated that these levels of disturbance would result in nest failure, nest-site abandonment, or disruption of roosting.

Periodic cutting of trees will occur to avoid hazards to people and infrastructure. If cutting a nest or roost tree becomes necessary, it will occur when bald eagles are not present as described in Chapter 7, Measure W-2. With this safeguard, operation and maintenance activities pose a very low potential for direct adverse impact to bald eagles.

**Effects of the HCP Measures**

Conservation measures implemented as part of the HCP to improve instream and riparian conditions for salmon will benefit bald eagles. Salmon are a major food source for bald eagles in the Pacific Northwest. Improved stream and riparian habitats will help sustain salmon populations and provide a reliable food source for bald eagles. The implementation of riparian conservation measures could cause short-term disturbance and temporarily decrease the availability of perch trees, but the disturbance will be localized, of short duration, and not regularly repeated in any one location.

Currently, there are no known bald eagle nests or communal winter night roosts in areas proposed for riparian conservation measures. If a nest or winter night roost did occur in the vicinity of a conservation measure location, impacts to bald eagles would be minimized by Conservation Measure W-2, which would restrict activity during the times bald eagles are present. Implementing stream and riparian conservation measures, even with potential short-term disturbance, will benefit bald eagles over the long term.

#### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will have little effect on individual bald eagles or on the regional bald eagle population. Bald eagle presence on covered lands is limited to occasional use of the reservoirs by transient bald eagles. No new construction or upland habitat modification is planned under the HCP that might alter bald eagle nesting or winter roosting habitat. The aquatic and riparian conservation measures will improve stream habitat conditions for spawning and rearing salmon, thereby benefiting foraging bald eagles.

### 8.6.2 Northern Spotted Owl *(Strix occidentalis caurina)*

#### Effects of Water Supply Operations and Related Activities

The existing water system facilities will not directly or indirectly affect spotted owls. The HCP will not involve the development of any new facilities or alteration of suitable spotted owl habitat. Power lines can cause bird mortality through collision and electrocution, but spotted owls are not generally at risk of either. Birds that are highly maneuverable flyers, such as owls, are less susceptible to collisions than other birds, and most power lines (including those in the Bull Run) are designed to prevent the electrocution of birds up to the size of large raptors. A bird's size is the primary factor influencing its risk of electrocution (Olendorff et al. 1981). Other aspects of a bird's behavior can also increase its vulnerability, such as nesting on power poles or frequently perching on them (Hunting 2002b). Since the spotted owl is a medium-sized raptor that does not nest on them and likely does not frequently perch on power poles, the risk of its being electrocuted is considered low.

Operation and maintenance of water-system facilities, including road use and routine maintenance (activities conducted on an annual or semiannual basis that move through an area or are completed in a relatively short period, such as ditch cleaning, brushing, grading, routine landscape and building maintenance, and boat/barge traffic), will not modify or affect spotted owl habitat in any way. Similarly, operation and maintenance of the water system will have a low likelihood of disturbing individual spotted owls. The owls are not particularly sensitive to human activity, and all existing spotted owl territories in the Bull Run were established since the water system went into operation in the early 20th century. These birds are likely habituated to the levels and locations of human activity that will continue under the HCP. Spotted owls have been reported killed by vehicles elsewhere within their range, but this source of mortality is infrequent, and most vehicle traffic occurs during daylight hours when spotted owls are less active.

Maintenance activities that are less frequent and require a more sustained use of heavy equipment in one location (e.g., road, large culvert and bridge reconstruction, major exterior building, and right-of-way maintenance) have the potential to disturb spotted owls if conducted during the nesting period and close to an active nest. However, seasonal restrictions and disturbance buffers in Measure W-1 will minimize or avoid the potential for disturbance related impacts. The potential for water system operation and maintenance to disturb spotted owls is therefore low and should not affect local spotted owl populations.

### Conclusions About the Habitat Effects of HCP Measure Implementation

Conservation measures implemented as part of the HCP are not expected to adversely affect spotted owls. Approximately four spotted owl sites may be relatively close (0.5 mile) to stream reaches scheduled for restoration activities. Such activities will be conducted along stream corridors, either within the stream or the adjacent riparian area, and affect a relatively small portion of the landscape relative to a typical spotted owl home range. Since these activities (like many of the maintenance activities) will be localized, of short duration, and not regularly repeated in any one area, the conservation measures are not expected to impact northern spotted owls.

## 8.6.3 Fisher *(Martes pennanti)*

### Effects of Water Supply Operations and Related Activities

The existing water system facilities will not affect the fisher. No new facilities are planned under the HCP, so there will be no removal or fragmentation of suitable fisher habitat. If a fisher population is reestablished in the project area, such establishment would be with the current facilities in place.

Operation and maintenance activities may potentially adversely affect fishers, should a population be reestablished in the future. Vehicle traffic along roads could directly affect fisher through collisions. However, the potential for vehicle collision involving fisher is very low because fisher are less active during the day when water system-related traffic is at its highest.

### Conclusions About the Habitat Effects of HCP Measure Implementation

The HCP will not adversely affect the fisher. Fishers are not currently known to be present in the areas affected by the HCP or in the northern Cascade Mountains of Oregon. Further, the HCP will not remove or modify suitable fisher habitat.

Conservation measure W-3 in the HCP may benefit the fisher if the species becomes reestablished in the Sandy River Basin.  A number of the other conservation measures will increase the volume of downed logs and the number of conifer trees in riparian areas. Both changes will improve habitat conditions for fishers over the long term.

The lack of a known local population and the limited amount of habitat modification that will occur under the HCP will result in limited, if any, effects on the fisher.

## 8.7 Effects of Covered Activities

Table 8-57 provides additional descriptive detail about the covered activities listed in Chapter 3, Section 3.4, and the associated effects on the habitat of the species that are covered and addressed in this HCP. In some cases, the activity and the effects are more fully described in other chapters. In those cases, cross-references are provided. This section is intended to complement, not repeat, the information provided by species elsewhere in this chapter and in the HCP.

**Table 8-57. Description of Covered Activities and Associated Potential Impacts, Conservation Measures, and Effects**

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Operation, Maintenance, and Repair of the Water Supply System** | | | |
| ***Storage of water in system reservoirs and regulation of reservoir surface elevations***<br>***Adjustment of water intake depth to regulate temperature, turbidity, and color***<br>(See Chapter 2 for more description.) | • Inundated riverine habitat and blocked access to the upper Bull Run watershed<br>• Potential for limited access to spawning tributaries for cutthroat and rainbow trout<br>• Potential for water quality effects on rearing resident trout in the reservoirs | • Reservoir Operations measure R-1<br>• Fish Passage measures P-1, P-2, P-3, and P-4<br>• Temperature measures T-1, T-2 | Effects are described in subsections 8.4.1 and 8.4.2, and sections 8.2, 8.3, 8.4, and 8.5.<br>Effects will be minimized. |
| ***Diversion of water for water supply***<br>***Release of water from reservoirs into the Bull Run River***<br>***Alternation of flows downstream from the water supply dams and diversion***<br>***Seasonal closure of gates at Dam 1 spillway to store additional water***<br>(See Chapter 2 for more description.) | • Reduced base flows for fish in the lower Bull Run River<br>• Potential for stranding juvenile fish in the lower Bull Run River | • Flow measures F-1, F-2<br>• Temperature measures T-1, T-2<br>• Reservoir Operation measure R-1<br>• Downramping measure F-3 | Effects are described in sections 8.2, 8.3, 8.4, and 8.5.<br>Effects will be avoided or minimized. |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Operation, Maintenance and Repair of the Water Supply System** | | | |
| ***Removal of wood from reservoirs***<br>Booms are used in both reservoirs to trap debris from winter storms and thereby avoid damage to the dams and associated spillways. Debris is defined as large and small logs and trees that wash down into the reservoirs. The majority of the material is collected at the upper boom in Reservoir 1. Water Bureau staff remove this material each spring at a landing near the upper boom. An excavator/loader is used to lift and remove the large wood and debris.<br>The wood is transported by winter storm flows from tributaries on federal land. The resulting wood is owned by the Forest Service. The Water Bureau has an agreement with the Forest Service to sort the material and to inform Forest Service staff if material suitable for Forest Service uses (e.g., fish habitat improvement and repair of historic structures) is available. | • Reduction in habitat diversity in the lower Bull Run and Sandy rivers<br>• Potential for small releases of petroleum products into reservoirs | • Large wood measures H-3, H-4, H-5, H-6, H-7, H-17, H-26, and H-27<br>• Spill Prevention measure O&M-2 | Effects are described in sections 8.2, 8.3, and 8.4.<br>Effects will be avoided or mitigated. |
| ***Operation of boats and barges on reservoirs***<br>A boat is used once a week on each reservoir to take routine water quality samples. The boat is lashed to the log boom or stored in an on-shore boat house when not in use. Infrequently, boats or small barges are used to complete maintenance or repair projects (e.g., to repair a broken boom). | • Potential for small releases of petroleum products into the reservoirs<br>• Potential for erosion from equipment on lake shore | • Spill Prevention measure O&M-2 | Effects will be avoided, or minimized. |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Operation, Maintenance, and Repair of the Water Supply System** | | | |
| ***Operation of boats and barges on reservoirs*** *(continued)*<br><br>Boats are moved from the boat house to the reservoir on a two-rail track to avoid erosion. The Water Bureau uses 4-cycle engines and avoids fuel spills given the potential water quality impacts to drinking water. Spill containment booms are stored in the boat houses located at each reservoir. Maintenance staff carry spill control kits in their vehicles. | | | |
| ***Delivery and storage of fuel and lubricants***<br><br>Fuel and lubricants are delivered to the Headworks facility. All deliveries are made via the road that parallels the lower Bull Run River. Fuel trucks use one of two paved routes and are guided by a pilot car. Fuel pumps are housed in concrete bunkers to avoid fuel releases. Secondary containment is provided to contain leaks if they occur. Containment basins are inspected, typically when the tanks are filled, and can be pumped if needed. | • Potential for releases of petroleum products into river or reservoirs | • Spill Prevention measure O&M-2 | • Effects will be avoided or minimized. |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Operation, Maintenance, and Repair of the Water Supply System** | | | |
| ***Delivery and storage of chlorine***<br>The Water Bureau uses chlorine gas to disinfect water diverted for water supply. Containers of gas (2,000 lbs. each) are delivered weekly during the summer and every two weeks during the winter. Trucks delivering the chlorine use one of two paved routes and are guided by a pilot car.<br>If a release of a reportable quantity (10 lbs.) were to occur, the Portland Fire Bureau would serve as incident commander, and the incident would be reported to the Oregon Emergency Response System (OERS).<br>The chlorine treatment system is equipped with chlorine scrubbers, so release of a reportable quantity is unlikely once the tanks are in use.<br>*Note: The City does not offload any other bulk chemicals into storage tanks at Headworks. The City's drinking water treatment also involves aqueous ammonia (as part of disinfection) and sodium hydroxide (to control corrosion). These chemicals are added at the City's Lusted Road facility, which is located outside the Sandy River Basin. The City is not requesting coverage for this facility in the HCP.* | • Potential release of chlorine gas<br>If a release occurred and owls or eagles were in the immediate vicinity of the spill, they could be harmed or killed by directly breathing the gas.<br>The dense gas would seek low elevations but would not affect the water quality of the streams. | • Chlorine handling is regulated by the U.S. Environmental Protection Agency and Occupational Safety and Health Administration (OSHA). No HCP measure is necessary. | • Effects will be avoided or minimized. |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Operation, Maintenance, and Repair of the Water Supply System** | | | |
| ***Draining of water supply conduits*** <br> Sections of the conduits are drained periodically for maintenance and repair or after operational shutdowns. The drained water is dechlorinated and then released into the nearest waterway. Water can be released at 52 locations between Headworks and Lusted Hill. The City uses diffusers to provide energy dissipation and to help prevent erosion. Dechlorination is done according to ODEQ "Guidelines for Disposal of Chlorinated Water." | • Potential discharge of chlorinated water | • Regulated by National Pollutant Discharge Elimination System permit. No HCP measure necessary. | Effects will be avoided or minimized. |
| ***General landscape maintenance*** <br> Water Bureau staff maintain landscaping at Bear Creek house, at Kaiser Park (an area that was once used for staff housing below Dam 2, near the spillway pool), and at Sandy River Station. No pesticides or herbicides are used. | • Potential use of chemicals | • No measure needed | Potential effects will be avoided. |
| **Habitat Conservation, Research and Monitoring Measures** | | | |
| Habitat conservation measures are described in Chapters 7 and 9. <br> Methodologies for research and monitoring measures are described in Appendix F. | | | Effects of the measures are described in this chapter. <br> Effects will be avoided or minimized. |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Incidental Land Management Activities**<br>The City owns approximately 3,800 acres of land in the Bull Run Watershed Management Unit, which includes land around and downstream of Reservoir 2. The City owns 1,200 acres of additional land along the lower Bull Run River and/or near the confluence of the Bull Run and Sandy Rivers, including at Dodge Park and the adjacent Sandy River Station maintenance facility. In total, this land fronts approximately 5.6 stream miles of the Bull Run and Sandy rivers. | | | |
| ***Management of City-owned riparian lands in the Bull Run watershed***<br>See also description below for management of conduit and bridges that traverse City-owned riparian lands. | • Potential reduction in large wood accumulation and instream habitat | • Riparian Land Protection measure H-2<br>• Terrestrial Wildlife measures W-1 and W-2<br>See also measures below for operation and maintenance of Sandy River Station and yard. | Effects will be avoided or minimized. |
| ***Operation, maintenance, and repair of power lines***<br>Two power line rights-of-way are included in the covered facilities: the City's power-line right-of-way and a Bonneville Power Administration (BPA) high-voltage line right-of-way on City land in the lower Bull Run watershed.<br><u>City's power line right-of-way</u><br>There are approximately 10 miles of 57-kV high-voltage power transmission lines in the watershed. | • Potential loss of habitat due to removal of trees that pose a specific hazard to the power lines<br>• Potential bird collisions<br>(See also description of potential collision impacts in Chapter 5, Section 5.3.1)<br>• Potential runoff of herbicides into river | • Terrestrial Wildlife measures W-1 and W-2 | Effects on bald eagles described in Section 8.6.1<br>Effects will be minimized. |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Incidental Land Management Activities** | | | |
| ***Operation, maintenance, and repair of power lines*** *(continued)*<br><br>From Dam 1 to Dam 2, the transmission lines closely follow the alignment of USFS roads and water conduit alignments. These lines connect to PGE's distribution system at the PGE Bull Run Hydroelectric Project Powerhouse on the lower Bull Run River.<br><br>A separate distribution system power line, operated and maintained by PGE, provides electrical service to the City's Headworks facility.<br><br>Vegetation management along the right-of-way occurs approximately once every three years. For the sections where the transmission lines share the alignment with the City's water supply conduits, City staff remove brush from the right-of-way. For the other sections, PGE hires contract staff to remove brush growing up under the power lines and trees that pose a specific hazard to the power lines. No herbicides are used.<br><br>Maintenance and repair of the lines and poles occur after storm damage. Trees, from time to time, fall into the lines during storms. PGE dispatches line repair crews to replace damaged poles and repair or replace lines as needed. | | | |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Incidental Land Management Activities** | | | |
| ***Operation, maintenance, and repair of power lines*** *(continued)*<br><br><u>BPA high-voltage line right-of-way on City land</u><br><br>One BPA 500-kV high-voltage power transmission line transects lands covered in the HCP. This north-south running power line easement crosses the lower Bull Run River at RM 2.1. BPA staff use all-terrain vehicles to access the easements so road maintenance is minimal. Vegetation management occurs approximately once every five years. BPA staff remove trees that pose a hazard to the power lines or to staff that maintaining the power lines, and BPA removes brush.<br><br>BPA has an agreement with the Forest Service not to use any chemical methods on federal land inside the Bull Run management unit. In response to a request from BPA, the Water Bureau has agreed to the use of Garlon 3A in a limited manner on the BPA transmission line easement on City land (located below the water supply intakes). The herbicide is used only as a stump treatment on hardwood tree species. | | | |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Incidental Land Management Activities** | | | |
| ***Maintenance and repair of roads, bridges, culverts, parking lots, and conduit rights-of way on non-federal land***<br>City staff maintain and repair roads on non-federal land. The most frequent maintenance activities have low noise impacts and produce transient sources of noise (i.e., mechanical removal of brush along primary roadways). Other activities are louder and can last for a longer period of time (i.e., bridge replacements). See wildlife measures W-1 and W-2 for a more thorough description of the road maintenance activities and the City's approach to avoiding or minimizing the impacts on spotted owls and bald eagles.<br>The water conduits cross the lower Bull Run River on three City-owned bridges: Headworks Bridge, Larson's Bridge, and Bowman's Bridge. The foundation footings for these bridges are located above the ordinary high water level and do not impede water flow or fish passage. The City recently upgraded these bridges for seismic protection reasons. Footings were replaced. Lead-based paint was removed, and the conduits and bridges repainted. The bridges were enclosed with tents and tarps during these projects to protect the river from failing debris and paint chips. | • Potential release of paint and debris into river<br>• Potential erosion and sedimentation, and elevated water turbidity<br>• Potential loss of bird habitat due to removal of trees that pose a hazard to the conduits or to staff<br>• Potential spills of chemicals or discharge of contaminated water | • Bull Run Infrastructure Operations and Maintenance measure O&M-1<br>• Terrestrial Wildlife measures W-1 and W-2 | Effects will be avoided or minimized. |

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| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Incidental Land Management Activities** | | | |
| ***Maintenance and repair of roads, bridges, culverts, parking lots, and conduit rights-of way on non-federal land*** *(continued)*<br><br>Conduit maintenance involves inspections, minor repair, and painting where the conduit pipes are exposed, as well as removal of brush that hinders inspection and removal of trees that pose a hazard to the conduits or to staff. Right-of-way maintenance on non-federal land is primarily for the water supply conduits. Three conduits are located downstream of Dam 2. Approximately 2,500 feet of conduit is exposed to the surface in the lower Bull Run River watershed (primarily near bridges); most of the conduit length is buried. Maintenance mostly involves removal of hazard trees.<br><br>The three conduits cross the mainstem Sandy River on two bridges near Dodge Park. The Water Bureau is planning to replace one of these bridges with a tunnel crossing within the next five years. The third conduit will remain on a bridge, which will be seismically upgraded. The City is not requesting ESA coverage for the conduit crossings on the Sandy River; ESA compliance will be addressed separately.<br><br>The only parking lot inside the management unit is located at Headworks. The parking lot is paved. Stormwater from the parking lot is discharged into the Bull Run River. | | | |

Table continued on next page.

| Covered Activity | Primary Historical or Potential Future Impacts Addressed[a] | Associated Habitat Conservation Measures[b] | Effects of Implementing HCP Measures[c] |
|---|---|---|---|
| **Incidental Land Management Activities** | | | |
| ***Operation and maintenance of the Sandy River Station and yard***<br><br>Sandy River Station is an approximately 5.5-acre maintenance facility located adjacent to the mainstem Sandy River, upstream of the mouth of the Bull Run River. Approximately 17 staff work out of this facility on a daily basis. Facilities include an office, a repair shop, fuel pumps/tanks, indoor storage (barn), parking, and outdoor equipment, vehicle, and materials storage.<br><br>All chemicals (e.g., paint, vehicle repair, fuel for chainsaws) used at this site are in small quantities (one gallon fuel cans and drums less than 20 gallons). Chemicals are stored indoors and on paved surfaces. Spill absorbent kits are available.<br><br>Fuel tanks (diesel and gasoline) pumps and tanks are located in the yard and within the floodplain of the Sandy River. Secondary containment is provided to contain leaks. Containment basins are inspected, typically when the tanks are filled, and can be pumped if needed.<br><br>The parking lot is part gravel and part pavement. Storm water is discharged to the Sandy River. | • Potential discharge of contaminated storm water<br>• Potential discharge of petroleum products into Sandy River during flood conditions<br>• Potential loss of riparian habitat due to removal of trees that threaten City facilities or pose a significant risk to human safety | • Bull Run Infrastructure Operations and Maintenance measure O&M-1 | Effects will be minimized. |

[a]Not comprehensive; see also background information in Chapters 2, 4, and 5.
[b]See descriptions in Chapter 7.
[c]See also description of current best management practices in column 1.